REVIEW ARTICLE Agricultural Reviews, Volume 47 Issue 3: 433-439 (June 2026)

Ecological Weed Management Practices in Maize (*Zea mays* L.): A Review

R. Chethan[1], B. Sandhya Rani[2], G. Karuna Sagar[3]

10.18805/ag.R-2666

ABSTRACT

In India the highest yield loss (34%) is caused by weeds, followed by insects (29%), pathogens (22%), storage pests (7%) and others (8%). Weeds compete with the crop for both above and below ground resources. Weed infestation is a serious challenge for maize growers in our country. Maize is sensitive to weeds especially during early stages of development and thus weed infestation from germination to 45 DAS causes maximum reduction in yield. Herbicides are efficient tools for checking weed infestation and its usage is increasing throughout the globe due to increasing labour cost and quick weed control in various situations. Continuous non-judicious use of herbicides for weed management leads to loss of biodiversity, environmental pollution and also develops herbicide resistance in weeds. Weed persistence is more in organic farming due to the extensive usage of organic manures, which act as weed seed reservoirs.

Key words: Allelo chemicals, Maize, Mulch, Organics, Weed management.

Maize (*Zea mays* L.) is the most versatile crop with wider adaptability to varied agro-ecological regions and diverse growing seasons. Besides serving as human food and animal feed, the importance of this crop also lies in its wide industrial applications. Maize is grown on 194 million ha area, in more than 170 countries across the globe with 1148 million metric tonns of production and with a productivity of 5755 kg ha^{-1}. In India during 2021 it is grown on 9.89 million ha area with 31.65 million tonnes of production and with a productivity of 3199 kg ha^{-1} (www.indiastat.com).

Among various biotic (insect, pest, predators, weed, *etc*.) and a biotic factors (drought, salinity, heat, *etc*.) that hinder maize production, weed is considered among the foremost factors restricting the maize crop yield (Neelam and Maneesha, 2022). Corn is sensitive to weeds especially during early stages of development and thus weed infestation from germination to 45 days after sowing (DAS) causes maximum reduction in yield and the extent of yield losses vary from 28-100% depending upon the intensity, nature and duration. Weeds not only decrease the crop yield but also harbour insect-pest and diseases and in some cases, they serve as an alternate host for pests.

Herbicide usage is a key component in almost all weed management strategies, but indiscriminate use of these herbicides has resulted in serious ecological and environmental problems. Presently, there are 58 weed species in corn which are resistant to herbicides. Weed persistence is more in organic farming due to the extensive usage of organic manures- which act as weed seed reservoirs, mulches, biomass which exacerbates the weed multiplication and growth (Sanbagavalli *et al.,* 2020). Keeping in view the importance of weed management in organic crop production a brief review is presented on the nature of weed spectrum in maize, competition between crops and weeds and different organic weed management practices.

[1]Department of Agronomy, S.V. Agricultural College, Acharya N.G. Ranga Agricultural University, Tirupati-517 502, Andhra Pradesh, India.

[2]Department of Agronomy, Regional Agricultural Research Station, Tirupati-517 502, Andhra Pradesh, India.

[3]University Librarian, Acharya N.G. Ranga Agricultural University, Lam, Guntur-522 034, Andhra Pradesh, India.

Corresponding Author: B. Sandhya Rani, Department of Agronomy, Regional Agricultural Research Station, Tirupati-517 502, Andhra Pradesh, India. Email: sandhya.reddy010@gmail.com

How to cite this article: Chethan, R., Rani, B.S and Sagar, G.K (2026). Ecological Weed Management Practices in Maize (*Zea mays* L.): A Review. *Agricultural Reviews.* **47(3):** 433-439. doi: 10.18805/ag.R-2666.

Submitted: 08-09-2023 **Accepted:** 06-04-2026 **Online:** 04-05-2026

Weed flora associated with maize

The predominant weed species observed in the experimental field of maize were *Cyperus rotundus*, *Digitaria sanguinalis*, *Dactyloctenium aegyptium*, *Blainvillea acmella*, *Lagascea mollis* and Commelina benghalensis on sandy loam soils of Tirupati andhra Pradesh (Saimaheswari *et al*., 2022). Krishnaprabu (2020) reported that predominant weed species observed in the maize experimental field were Ageratum conyzoides, Alternanthera *Phyloxeroides*, *Bidens pilosa*, *Borreria hispida*, *Galinsoga parviflora* and *Spilanthesacmella* among the broadleaved weeds, *Cynodondactylon*, *Digitaria marginata*, *Digitaria sanguinalis*, *Panicum repens* and *Eleusine indica* among grasses and *Cyperus rotundus* and *Fimbristylis miliacea* among sedges in sandy clay loam soils of Annamalainagar, Tamil Nadu. Lavanya *et al*. (2020) observed that the most dominant weeds in maize

were *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Echinochloa colona*, *Amaranthus viridis*, *Digera arvensis* and *Trianthema portulacastrum* in sandy loam soils of Coimbatore, Tamil Nadu. The predominant weed species associated with corn were *Trianthema portulacastrum*, *Digera arvensis*, *Echinochloa colona*, *Digitaria longiflora*, *Dactyloctenium aegyptium* and *Parthenium hysterophorus* in sandy clay loam soils of Coimbatore, Tamil Nadu (Sathyapriya and Chinnusamy, 2020). Nazir *et al.* (2019) observed that the major weeds associated with baby corn in Manasbal, Kashmir were *Cynodon dactylon*, *Sorghum halepense*, *Poa annua*, *Portulaca oleracea*, *Convolvulus arvensis*, *Amaranthus viridis*, *Chenopodium album* and *Cyperus rotundus*. The predominant weed species observed in the experimental field of maize were *Cyperus rotundus* a sedge, *Cynodon dactylon* among grasses and *Digera arvensis*, *Trianthema portulacastrum*, *Cleome viscosa* and *Phyllanthus niruri* among broadleaved weeds in sandy clay loam soils of Killikulam, Tamil Nadu (Naik and Velayutham, 2018). Rajeshkumar *et al*. (2018) noticed grasses like *Echinochloa colona*, *Eleusine indica* and *Dactyloctenium aegyptium*, *Cyperus rotundus* a sedge and *Trianthema portulacastrum*, *Boerhavia diffusa* and *Digera arvensis* among the broadleaved weeds in maize in clay loam soils of Madurai, Tamil Nadu. Kumar *et al*. (2017) observed the infestation of *Cynodon dactylon*, *Cyperus rotundus*, *Amaranthus viridis*, *Anagalis arvensis*, *Argemone mexicana*, *Chenopodium album*, *Melilotus indica*, *Oxalis corniculata*, *Convolvulus arvensis*, *Rumex retroflex* and *Parthenium hysterophorus* in maize field on sandy loam soils of Sabour, Bihar. Ram *et al*. (2017) reported that predominant weed species associated with maize in sandy loamy soils of Hyderabad, Telangana were *Parthenium hysterophorus*, *Melilotus alba*, *Cyperus rotundus*, *Trianthema portulacastrum*, *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Digera muricata*, *Amaranthus viridis*, *Commelina benghalensis*, *Eragrostis unioloides*, *Chenopodium album*, *Trichodesma indicum*, *Digitaria sanguinalis*, *Euphorbia geniculata* and *Echinochloa colona*.

Weed competition

The critical period of crop weed competition varies from 2 to 7 WAS in maize (Shrestha *et al*., 2019). Imoloame and Omolalye (2017) observed that weed interference in maize from 3 to 6 WAS significantly depressed the growth parameters and kernel yield of maize. Das *et al*. (2016) reported that initial 6 WAS was found to be very susceptible to weed infestation in maize. Singh *et al*. (2016) noticed that in spring maize, the critical crop weed competition period starts from 30 DAS and continued up to 60 DAS. Critical period for weed removal ranged from 21 to 29 DAS in maize to prevent yield losses (Amare *et al*., 2014). Fahad *et al*. (2014) reported that infestation of weeds at every stage of crop led to significant yield loss in maize and weed competition during the early crop growth stages of maize should be low to achieve higher yields. The period of high emergence of weeds in maize was between 3 and 8 to 10 weeks after planting (Takim *et al*., 2014).

Yield loss due to weeds in maize

Shrestha *et al*. (2019) reported that weed infestation might led to 20 to 80 per cent reduction in maize yield. Imoloame and Omolalye (2017) observed 89 per cent yield loss in maize as a result of uncontrolled weed infestation. Kernel losses in maize varied between 28-100 per cent, if weeds were not controlled during the critical period of crop weed competition (Kumar *et al*., 2017). During *Kharif* season maize suffers from heavy weed infestation, which may cause yield losses ranging from 28-100 per cent depending upon the intensity and nature of infestation of weeds (Das *et al*., 2016). Weeds in maize cause substantial yield loss ranging from 18 to 85 per cent (Jagadish *et al*., 2016). Presence of weeds in winter maize reduced the maize yields by 27-60 per cent, depending upon the growth and persistence of weed population (Anil *et al*., 2015). Yakadri *et al*. (2015) stated that there was a yield reduction of 77, 44 and 38 per cent due to grasses, broadleaved weeds and sedges respectively in maize.

Effect of organic weed management practices on weed dynamics, growth, yield and economics of maize

Weed density and dry weight

Saimaheswari *et al*. (2022) reported that hand weeding twice at 15 and 30 DAS recorded significantly lower density and biomass of grasses, sedges, broadleaved and total weeds over the rest of treatments in maize. Masud *et al*. (2021) observed significantly lower weed biomass with cowpea live mulch when compared to rest of the treatments in maize. Asif *et al*. (2020) reported that application of saw dust mulch at 4 t ha^{-1} recorded significantly lower weed density and dry weight when compared to control in maize. Kaur *et al*. (2019) stated that live mulch with cowpea has significantly reduced the weed density and weed dry matter, which was however comparable with moong bean live mulch in maize. Two hand weedings at 20 and 40 DAS recorded significantly lowest weed density and dry weight at 30, 45 and 60 DAS in maize (Soren *et al.,* 2018). Stanzen *et al.* (2017) observed minimum density and biomass of weeds with two hand weedings at 15 and 30 DAS in maize. Foliar application of combined aqueous extracts of sorghum and sunflower each at 15 L ha^{-1} at 20 DAS of corn reduced the density of *Trianthema portulacastrum* by 46 per cent and *Cyperus rotundus* by 56 per cent respectively (Naeem *et al*., 2016). Seremesic *et al*. (2016) reported that pre emergence application of maize gluten at 3 t ha^{-1} resulted in significant reduction in weed density in maize. Arif *et al*. (2015) stated that combined exogenous application of sorghum, sunflower and brassica extract at 18 L ha^{-1} at 25 and 40 DAS significantly suppressed the weeds number and biomass in maize. Application of aqueous extract of sunflower along with sorghum and brassica aqueous extracts each at 15 L ha^{-1} twice at 15 and 30 DAS resulted in reduction of weed density by 74 per cent in maize (Ihsan *et al*., 2015). Jamshidi *et al*. (2013) concluded that planting of maize at a density of 9 plants m^{-2}

and simultaneously intercropping with cowpea at a density of 30 plants m^{-2} effectively suppressed the weed growth and biomass by 39.6 per cent. Combined application of mixture of sorghum, sunflower and rice allelopathic water extracts each at 15 L ha^{-1} reduced the density of barnyard grass, flat sedge and crowfoot grass by 75, 67 and 74 per cent and their dry weight by 66, 71 and 76 per cent respectively in rice (Rehman *et al*., 2012). Talebbeigi and Ghadiri (2012) reported that growing cowpea as a live mulch at 22 plants m^{-2} with a suppression period of 75 days recorded lowest weed biomass and dry weight of weeds at harvest of maize. Corn gluten meal as pre emergence application at 300 g m^{-2} inhibited root elongation of many broadleaf weeds in greenhouse studies (Hebert and lyons, 2011). Pre emergence application of corn gluten meal at 4 t ha^{-1} provided complete control of *Dactyloctenium aegyptium*, *Lolium multiflorum* and *Eleusine indica* and substantial inhibition of *Setaria viridis* and moderate control of *Sorghum halepense* and *Cyperus esculentus* in green house studies (Abouziena *et al*., 2009).

Weed control efficiency

Baldaniya *et al*. (2018) reported that hand weeding twice at 20 and 40 DAS recorded highest weed control efficiency compared to pre and post emergence herbicide application treatments in corn. Hand weeding at 20 and 40 DAS recorded the highest weedcontrol efficiency at all the growth stages of maize compared to rest of the weed management practices tested (Gupta *et al.,* 2018). Enhanced weed control efficiency at all the growth stages of maize was noticed with hand weeding performed at 20 and 40 DAS (Satyendra *et al*., 2018). Kumar *et al*. (2017) observed that cowpea live mulch in maize registered highest weed control efficiency at 15, 35 and 60 DAS when compared to rest of the treatments. At physiological maturity stage of maize, significantly higher WCE was noticed in live mulch with cowpea and was at par with black and white polythene mulch (Ram *et al*., 2017). Webber *et al*. (2008) noticed that application of corn gluten meal at 4000 kg ha^{-1} recorded 72 per cent of total weed control and 83 per cent of broadleaf weed control up to 46 days after planting in spring transplanted corn.

Weed index

Dhivya *et al*. (2021) noticed that groundnut shell mulch at 5 t ha^{-1} + one hand weeding at 20 DAS recorded the lowest weed index when compared to intercropping with dhaincha and *in-situ* incorporation on 30 DAS in corn. Vidyashree *et al*. (2019) reported that application of mango leaves mulch between the rows of sunflower at 4 t ha^{-1} recorded significantly lower weed index when compared to live mulch with sunhemp at 40 kg ha^{-1}. Hand weeding and intercultivation at 15 and 30 DAS recorded significantly minimum weed index when compared to rest of the treatments tried in popcorn (Barad *et al*., 2016).

Phytotoxicity of maize

Germination percentage of maize was inhibited by dry aqueous extracts of maize leaf by 7.81%, germination index by 16.51%, increased mean germination time by 25.53%, decreased plumule and radical lengths by 29.00 and 36.12% respectively and lowered maize seedling dry biomass by 34.02% (Hussain *et al*., 2018). Rawat *et al*. (2013) reported that application of sunflower extract at 15 per cent concentration twice at 15 and 30 DAS inhibited the germination and growth of *Vigna radiata* and *Pennisetum glaucum* in a laboratory experiment. The allelochemicals secreted by sunflower inhibited germination, reduced the shoot length, root length, fresh weight, dry weight and chlorophyll content and increased the values of ABA, protein, proline, sugar, superoxide dismutase and peroxidase contents in maize seedlings (Kamal, 2011). Khan *et al*. (2007) revealed that eucalyptus aqueous extract application at 10 g L^{-1} of water reduced the seed germination of maize by 12 to 18 per cent over water applied treatment in pot culture experiment. Eucalyptus boiled extract decreased seed germination by 66 per cent when compared to 99 per cent germination in the control treatment in maize.

Growth parameters of maize

Masud *et al*. (2021) observed significantly tallest plants in maize by live mulch with cowpea when compared to rest of the treatments. Application of saw dust mulch at 4 t ha^{-1} recorded significantly higher plant height when compared to control in maize (Asif *et al*., 2020). Bako *et al*. (2020) recorded significantly highest plant height, stem girth, number of leaves $plant^{-1}$ and leaf area index with application of groundnut shells at 7.5 t ha^{-1} when compared to rest of the treatments in maize. Hand weeding twice at 20 and 40 DAS recorded significantly higher plant height, leaf area index and dry matter production in maize (Kandasamy, 2018). Saw dust mulch at 4 t ha^{-1} recorded higher number of leaves $plant^{-1}$, plant height, stem girth, leaf area index and dry matter production in maize (Wuese *et al*., 2018). Hand weeding twice at 20 and 40 DAS resulted in maximum plant height, leaf area index and dry matter production in maize (Ram *et al*., 2017). Foliar application of aqueous plant extracts of sorghum and sunflower each at 15 L ha^{-1} at 20 DAS increased the dry matter production of maize by 69 per cent when compared to control (Naeem *et al*., 2016). Mathukia *et al*. (2015) noticed significantly highest plant height, leaf area index, dry matter production, plant spread and number of branches $plant^{-1}$ with the groundnut shells mulch at 5 t ha^{-1}, which was comparable with wheat straw mulch at 5 t ha^{-1}. Ihsan *et al*. (2015) noticed that application of sunflower plant water extract along with sorghum and brassica aqueous extracts each at 18 L ha^{-1} twice at 15 and 30 DAS resulted in increased plant height by 20 per cent in maize.

Yield attributes and yield of maize

Masud *et al*. (2021) observed increased kernel and stover yield with cowpea live mulch when compared to rest of the treatments in maize. Asif *et al*. (2020) reported that application of saw dust mulch at 4 t ha^{-1} recorded significantly higher number of kernels cob^{-1}, kernel weight cob^{-1}, 100 kernel weight, kernel yield, stover yield and harvest index in maize.

Bako *et al*. (2020) recorded significantly higher cob length, cob girth, number of kernels cob^{-1}, 100 kernel weight, stover yield, kernel yield and harvest index of maize with application of groundnut shells as mulch at 7.5 t ha^{-1} when compared to rest of the treatments. Khan *et al*. (2020) reported significantly higher kernel weight cob^{-1}, number of kernels cob^{-1}, kernel yield and harvest index of maize with hand weeding twice at 20 and 40 DAS in maize. Mahto *et al*. (2020) revealed that significantly higher cob length, cob girth, number of kernel rows cob^{-1}, 100 kernel weight and kernel yield of maize was recorded with hand weeding twice at 20 and 40 DAS. Hand weeding twice at 15 and 30 DAS recorded higher cob length, cob girth, kernel rows cob^{-1}, number of kernels cob^{-1}, 100 kernel weight, kernel yield and stover yield when compared to other treatments in maize (Rani *et al*., 2019). Prithwiraj *et al.* (2018) reported highest green cob yield of maize with hand weeding twice at 20 and 40 DAS.

Higher cob length, cob diameter, number of kernels row^{-1}, number of kernels cob^{-1}, test weight and kernel yield of maize was recorded under maize + cowpea as live mulch treatment (Kumar *et al*., 2017). Kurre *et al*. (2017) recorded highest kernel yield of maize with hand weeding twice at 20 and 40 DAS when compared to rest of the treatments. Parameswari *et al*. (2017) reported that the number of kernels cob^{-1}, kernel weight cob^{-1}, test weight, stover yield and kernel yield were found to be significantly higher with hand weeding twice at 20 and 40 DAS in maize. Ram *et al*. (2017) observed significantly higher kernel yield in live mulch with cowpea in maize when compared to weedy check. Triveni *et al*. (2017) noticed significantly higher cob length, cob girth, number of kernel rows cob^{-1}, test weight, kernel yield and stover yield with hand weeding twice at 20 and 40 DAS in maize. Srawet *al*. (2016) reported that higher cob length, cob girth, number of kernel rows cob^{-1}, number of kernels cob^{-1} and kernel yield of maize was recorded in live mulch with cowpea as compared to rest of the treatments tried. Samanth *et al*. (2015) reported higher cob length, cob weight, number of kernels cob^{-1}, 100 kernel weight and kernel yield of maize with hand weeding twice at 20 and 40 DAS. Higher kernel yield of maize was recorded with hand weeding twice at 20 and 40 DAS when compared to rest of the treatments tried (Dash and Mishra, 2014). Jamshidi *et al*. (2013) observed that under weed infested conditions, intercropping of maize with cowpea as a live mulch increased kernel yield of maize. Talebbeigi and Ghadiri (2012) reported higher number of kernel rows cob^{-1}, number of kernels row^{-1}, number of kernels cob^{-1}, test weight and kernel yield with cowpea live mulch at 22 plants m^{-2} in maize.

Nutrient uptake by maize crop

Two hand weedings at 15 and 30 DAS recorded significantly higher total N, P and K uptake by sweet corn when compared to rest of the treatments (Bhalerao *et al*., 2020). Hiremath *et al*. (2020) reported that live mulch of sunhemp with maize in 1:2 ratio recorded significantly higher uptake of N, P and K by maize. Maximum uptake of N, P and K by maize was recorded with two hand weedings at 15 and 30 DAS when compared to rest of the treatments (Jaybhaye *et al*., 2019); Yadav *et al*. (2018) found that highest uptake of N, P and K by kernel and stover of maize was recorded with two hand weedings at 20 and 40 DAS. Hand weeding twice at 15 and 30 DAS recorded significantly highest uptake of nutrients by maize when compared to rest of the treatments (Lakshmi and Martin, 2017); Samant *et al*. (2015) concluded that maximum uptake of N, P and K by maize was observed with two hand weedings at 20 and 40 DAS. Among weed management practices, highest N, P and K removal by kernel and stover of winter maize was noticed with hand weeding twice at 15 and 30 DAS (Kour *et al*., 2014).

Nutrient uptake by weeds in maize

Live mulch with cowpea up to 50 DAS recorded significantly lowest N, P and K uptake by weeds at harvest of maize (Choudhary and Ezung, 2020). Jaybhaye *et al*. (2019) observed that two hand weedings at 15 and 30 DAS recorded significantly lowest nutrients removal by weeds in maize. Swetha *et al*. (2018) reported that nitrogen, phosphorus and potassium uptake by weeds at harvest was significantly lower in hand weeding at 20 and 40 DAS when compared to rest of the treatments in maize. Hand weeding twice at 15 and 30 DAS recorded significantly the lowest uptake of nutrients by weeds when compared to rest of the treatments in maize (Lakshmi and Martin, 2017). Stanzen *et al*. (2017) recorded significantly lowest N, P and K uptake by weeds with two hand weedings at 15 and 30 DAS in maize. Samant *et al*. (2015) concluded that minimum uptake of N, P and K by weeds was observed with two hand weedings at 20 and 40 DAS in maize. Among all the weed management practices, the uptake of N, P and K by weeds in maize was found to be significantly lowest in hand weeding twice at 15 and 30 DAS (Kour *et al*., 2014).

Economics

Hiremath *et al*. (2020) reported that live mulch of sunhemp with maize in 1:2 ratio recorded significantly higher net returns and B:C ratio in maize. Dutta *et al*. (2016) recorded maximum net returns and B:C ratio with hand weeding twice at 20 and 40 DAS in maize. Maize intercropped with cowpea as a live mulch upto 30 DAS recorded maximum net returns and B:C ratio when compared to control (Sraw *et al*., 2016). Post emergence combined application of aqueous extracts of sorghum+ sunflower+ brassica each at 18 l ha^{-1} at 25 and 40 DAS gave higher net returns in maize (Arif *et al*., 2015); Samant *et al*. (2015) recorded maximum gross returns, net returns and B:C ratio withtwo hand weedings at 20 and 40 DAS in maize. Singh *et al.* (2015) noticed significantly highest gross returns, net returns and B:C ratio with cowpea as a live mulch in maize. Maximum net returns and B:C ratio were realized with hand weeding and intercultivation at 15 and 30 DAS in sweet corn (Dobaria *et al*., 2014). The maximum gross returns was obtained with hand weeding twice at 20 and 40 DAS in maize when compared to rest of the treatments (Sanodiya *et al*., 2013).

CONCLUSION

Weeds have a more direct influence on yields of crops than any other pest in developing countries like India. Weeds not only cause severe crop losses but also compete with farmers and their families to spend a considerable amount and their time on weeding. Different weed control methods have been used to manage the weeds but the usage of herbicides is restricted in organic farming. In organic farming weeds can be effectively managed by mechanical weeding, Hand hoeing, Hand weeding, application of organic mulches, growing of live mulches, inter cropping and cover crops. Apart from the above allelopathy and mycoherbicides can play an important role in reducing the weed infestation.

Conflict of interest

All authors declare that they have no conflicts of interest.

REFERENCES

Abouziena, H.F., Omar, A.A., Sharma, S.D. and Singh, M. (2009). Efficacy comparison of some new natural product herbicides for weed control at two growth stages. *Weed Technology*. **23:** 431-437.

Amare, T., Amin, M. and Negeri, M. (2014). Management of weeds in maize (*Zea mays* L.) through various pre and post emergence herbicides. *Advances in Crop Science and Technology.* **2(5):** 1-5.

Anil, K., Jai, K., Puniya, R., Amit, M., Neetu, S. and Lobzang, S. (2015). Weed management in maize based cropping system. *Indian Journal of Weed Science.* **47(3):** 254-266.

Arif, M., Cheema, Z.A., Khaliq, A. and Hassan, A. (2015). Organic weed management in wheat through allelopathy. *International Journal of Agriculture and Biology.* **17(1):** 127-134.

Asif, M., Nadeem, M.A., Aziz, A., Safdar, M.E., Adnan, M., Ali, A., Ullah, N., Akhtar, N. and Abbas, B. (2020). Mulching improves weeds management, soil carbon and productivity of spring planted maize (*Zea mays* L.). *International Journal of Botany Studies.* **5(2):** 57-61.

Bako, T., Mamai, E.A. and Istifanus, A.B. (2020). Effect of groundnut shells on soil properties, growth and yield of maize. *Net Journal of Agricultural Science.* **8(4):** 73-81.

Baldaniya, M.J., Patel, T.U., Zinzala, M.J., Gujjar, P.B. and Sahoo, S. (2018). Weed management in fodder maize (*Zea mays* L.) with newer herbicides. *International Journal of Chemical Studies.* **6(5):** 2732-2734.

Barad, B., Mathukia, R.K., Gohil, B.S. and Chhodavadia, S.K. (2016). Integrated weed management in *rabi* popcorn (*Zea mays var. everta*). *Journal of Crop and Weed.* **12(1):** 150-153.

Bhalerao, V.P., Rathod, R.K., Margal, P.B., Doiphode, K.M. and Kamble, B.M. (2020). Nutrient uptake as influenced by pre and post emergence herbicide in sweet corn grown in vertisols. *The Pharma Innovation Journal.* **10(1):** 439-442.

Choudhary, J.K. and Ezung, K. (2020). Non herbicidal weed and organic nutrient management in maize under rainfed maize-sesamum cropping sequence. *Current Agriculture Research Journal.* **8(3):** 193-207.

Dash, R.R. and Mishra, M.M., (2014). Bioefficacy of halosulfuron-methyl against sedges in maize. *Indian Journal of Weed Science.* **46(3):** 267-269.

Das, A., Kumar, M., Ramkrushna, G.I., Patel, D.P., Layek, J., Panwar, A.S. and Ngachan, S.V. (2016). Weed management in maize under rainfed organic farming system. *Indian Journal of Weed Science.* **48(2):** 168-172.

Dhivya, S., Kalpana, R., Murali Arthanari, P. and Senthil, A. (2021). Effect of non chemical weed management practices on weed dynamics and yield in organic okra (*Abelmoschus esculentus* L.). *The Pharma Innovation Journal.* **10(10):** 1417-1421.

Dobariya, V.K., Mathukia, R.K., Gohil, B.S. and Chhodavadia, S.K. (2014). Integrated weed management in sweet corn. *Indian Journal of Weed Science.* **46(2):** 195-196.

Dutta, D., Thentu, T.L. and Duttamudi, D. (2016). Effect of weed management practices on weed flora, soil micro flora and yield of baby corn (*Zea mays* L.). *Indian Journal of Agronomy*. **61(2):** 210-216.

Fahad, S., Hussain, S., Saud, S., Hassan, S., Muhammad, H., Shan, D., Chen, C., Wu, C., Xiong, D., Khan, S.B. and Jan, A. (2014). Consequences of narrow crop row spacing and delayed *Echinochloa colona* and *Trianthema portulacastrum* emergence for weed growth and crop yield loss in maize. *Weed Research.* **54(5):** 475-483.

Gupta, S.K., Mishra, G.C. and Purushottam, K. (2018). Efficacy of pre and post emergence herbicides on weed control in *kharif* maize (*Zea mays* L.). *International Journal of Chemical Studies*. **6(1):** 1126-1129.

Hebert, F. and Lyons, E. (2011). What is the future for corn gluten meal based products for controlling weeds. *Spring.* **24(2):** 18-21.

Hiremath, K.A., Halepyati, A.S., Dodamani, B.M. and Bellakki, M.A. (2020). Biomass production and N accumulation of brown and green manuring of legume intercrops on yield, N uptake and economics of maize-wheat cropping system under upper krishna project command. *Journal of Pharmacognosy and Phytochemistry.* **9(2):** 1004-1009.

Hussain, Khan, A., Sabir, A.A., Umer, K., Imam, B., Yasir, I. (2018). Allelopathic effect of various aqueous plant extracts on weeds and yield of maize (Zea *mays* L.). *International Journal of Biosciences.* **12(5):** 167-173.

Ihsan, M.Z., Khaliq, A., Mahmood, A., Naeem, M., El Nakhlawy, F. and Alghabari, F. (2015). Field evaluation of allelopathic plant extracts alongside herbicides on weed management indices and weed crop regression analysis in maize. *Weed Biology and Management.* **15(2):** 78-86.

Imoloame, E.O. and Omolaiye, J.O. (2017). Weed infestation, growth and yield of maize (*Zeamays* L.) as influenced by periods of weed interference. *Advances in Crop Science and Technology.* **5(2):** 1-7.

Jagadish, K., Shrinivas, C.S. and Prashant, C. (2016). A review on weed management on maize (*Zea mays* L.). *Advances in Life Sciences*. **5(9):** 3448-3455.

Jamshidi, K., Yousefi, A.R. and Oveisi, M. (2013). Effect of cowpea (*Vigna unguiculata*) intercropping on weed biomass and maize (*Zea mays* L.) yield. *New Zealand Journal of Crop and Horticultural Science.* **41(4):** 180-188.

Jaybhaye, J.N., Kakade, S.U., Thombre, S.V., Saoji, B.V., Deshmukh, J.P. and Ingle, Y.V. (2019). Efficacy of different pre and post emergence herbicides on nutrient uptake and microbial observation in maize (*Zea mays* L.). *Journal of Pharmacognosy and Phytochemistry*. **8(5):** 1058-1061.

Kamal, J. (2011). Impact of allelopathy of sunflower (*Helianthus annuus* L.) roots extract on physiology of wheat (*Triticum aestivum* L.). *African Journal of Biotechnology.* **10(65):** 14465-14477.

Kandasamy, S. (2018). Studies on weed management in irrigated maize. *Journal of Agricultural Research*. **3(1):** 1-3.

Kaur, M., Singh, G. and Singh, A. (2019). Weed management in spring maize (*Zea mays*) through cultural practices in Punjab. *Journal of Krishi Vigyan.* **7(2):** 257-261.

Khan, I.A., Rehman, O.U., Khan, S.A., Alsamadany, H. and Alzahrani, Y. (2020). Effect of different herbicides, plant extracts and mulches on yield and yield components of maize. *Planta Daninha.* **38(1):** 74-79.

Khan, M.A., Hussain, I. and Khan, E.A. (2007). Effect of aqueous extract of *Eucalyptus camaldulensis* L. on germination and growth of maize (*Zea mays* L.). *Pakistan Journal of Weed Science and Reaserch.* **13(3 and 4):** 177-182.

Kour, P., Kumar, A., Sharma, B.C., Kour, R. and Sharma, N. (2014). Nutrient uptake as influenced by weed management in winter maize + potato intercropping system. *Indian Journal of Weed Science.* **46(4):** 336-341.

Krishnaprabu, S. (2020). Performance of weed control practices in maize under rainfed organic farming system. *Plant Archives*. **20(1):** 2896-2900.

Kumar, B., Prasad, S., Mandal, D. and Kumar, R. (2017). Influence of integrated weed management practices on weed dynamics, productivity and nutrient uptake of *rabi* maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences.* **6(4):** 1431-1440.

Kurre, D.K., Bharati, V., Singh, A., Kumar, M. and Prasad, S.S. (2017). Impact of herbicides on yield, economics and phytotoxicity in *kharif* maize. *The Pharma Innovation Journal.* **6(11):** 190-192.

Lakshmi, P.V. and Martin, M.M. (2017). Studies on influence of herbicides on nutrient uptake and yield in maize. *International Journal of Farm Sciences.* **7(1):** 37-39.

Lavanya, Y., Srinivasan, K., Chinnamuthu, C.R., Murali, P.A., Shanmuga-sundaram, S. and Chandrasekhar, C.N. (2020). Study on effect of weed management practices on weed dynamics and productivity of *kharif* maize. *The Pharma Innovation Journal*. **10(1):** 662-665.

Mahto, R., Kumar, C. and Singh, R.K. (2020). Weed management in maize (*Zea mays* L.) through 4 hydroxyphenylpyruvate dioxygenase inhibitor herbicide with or without a methylated seed oil adjuvant. *Pesticide Research Journal.* **32(1):** 179-185.

Masud, M., Dokurugu, F. and Kaba, J.S. (2021). Effectiveness of cowpea (*Vigna unguiculata* L.) living mulch on weed suppression and yield of maize (*Zea mays* L.). *Open Agriculture.* **6(1):** 489-497.

Mathukia, R.K., Mathukia, P.R. and Polara, A.M. (2015). Effect of preparatory tillage and mulch on productivity of rainfed pigeonpea (*Cajanus cajan* L.). *Indian Journal of Dryland Agricultural Research and Development.* **30(2):** 58-61.

Naeem, M., Mahmood, A., Ihsan, M.Z., Daur, I., Hussain, S., Aslam, Z. and Zamanan, S.A. (2016). *Trianthema portulacastrum* and *Cyperus rotundus* interference in maize and application of allelopathic crop extracts for their effective management. *Planta Daninha.* **34(2):** 209-218.

Naik, R.N.V. and Velayutham, A. (2018). Weed dynamics and productivity of hybrid maize (*Zea mays* L.) as affected by integrated weed management practices. *International Journal of Current Microbiology and Applied Sciences*. **7(3):** 2984-2989.

Nazir, A., Bahar, F.A., Rashid, Z., Fayaz, S., Bhat, T.A. and Ahmad, O. (2019). Weed dynamics of baby corn (*Zea mays* L.) as influenced by different weed management practices under the temperate conditions of Kashmir valley. *Bulletin of Environment Pharmacology and Life Sciences.* **8(7):** 99-103.

Neelam, S. and Manisha, R. (2022). Different aspects of weed management in maize (*Zea mays* L.): A Brief Review. *Advances in Agriculture.* **2:** 10-20.

Parameswari, Y.S., Srinivas, A. and Ram Prakash, T. (2017). Productivity and economics of Rice (*Oryza sativa*)- zero till maize (Zea mays) as affected by rice establishment methods and weed management practices. *International Journal of Current Microbiology and Applied Sciences.* **6(10):** 945-952

Prithwiraj, D., Pratap, T., Singh, V.P., Rohitashav, S. and Singh, S.P. (2018). Weed management options in spring sweet corn [*Zea mays* (L.) saccharata]. *International Journal of Chemical Studies.* **6(5):** 647-650.

Rajeshkumar, A., Venkataraman, N.S. and Ramadass, S. (2018). Integrated weed management in maize-based intercropping systems. *Indian Journal of Weed Science.* **50(1):** 79-81.

Ram, P., Sreenivas, G. and Leela Rani, P. (2017). Impact of sustainable weed management practices on growth, phenology and yield of *rabi* grain maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences*. **6(7):** 701-710.

Rani, B.S., Chandrika, V., Reddy, G.P., Sudhakar, P., Nagamadhuri, K.V. and Sagar, G.K. (2019). Weed dynamics and nutrient uptake of maize as influenced by different weed management practices. *Indian Journal of Agricultural Research.* **56(3):** 283-289.

Rani, B.S., Chandrika, V., Sagar, G.K. and Reddy, G.P (2020). Weed management practices in maize (*Zea mays* L.): A review. *Agricultural Reviews.* **41(4):** 328-337.

Rawat, L.S., Maikhuri, R.K. and Negi, V.S. (2013). Inhibitory effect of leachate from *Helianthus annuus* on germination and growth of *kharif* crops and weeds. *Acta Ecologica Sinica.* **33(5):** 245-252.

Rehman, A., Cheema, Z.A., Khaliq, A., Arshad, M. and Mohsan, S. (2012). Application of sorghum, sunflower and rice water extract combinations helps in reducing herbicide dose for weed management in rice. *International Journal of Agriculture and Biology.* **12(6):** 901-906.

Saimaheswari, K., Sagar, G.K., Chandrika, V., Sudhakar, P. and Krishna, T.G. (2022). Effect of nitrogen and weed management practices in maize and their residual effect on succeeding groundnut. *Indian Journal of Weed Science.* **54(1):** 36-41.

Samant, T.K., Dhir, B.C. and Mohanty, B. (2015). Weed growth, yield components, productivity, economics and nutrient uptake of maize (*Zea mays* L.) as influenced by various herbicide applications under rainfed condition. *Indian Journal of Weed Science.* **2(1):** 79-83.

Sanbagavalli, S., Jeeva, M. and Somasundaram, E. (2020). Eco-friendly weed management options for organic farming: A review. *The Pharma Innovation Journal.* **9(11):** 15-18.

Sanodiya, P., Jha, A.K. and Shrivastava, A. (2013). Effect of integrated weed management on seed yield of fodder maize. *Indian Journal of Weed Science.* **45(3):** 214-216.

Sathyapriya, K. and Chinnusamy, C. (2020). Integrated weed management in altered crop geometry of irrigated maize and residual effects on succeeding bengal gram. *Indian Journal of Weed Science.* **52(1):** 93-98.

Satyendra, K.G., Mishra, G.C. and Purushottam, K. (2018). Efficacy of pre and post emergence herbicide on weed control in *kharif* maize (*Zea mays L.). International Journal of Chemical Studies*. **6(1):** 1126-1129.

Seremesic, S., Nikolic, L., Milosev, D., Zivanov, M., Dolijanovic, Z. and Vasiljevic, M. (2016). The possibility of maize gluten application for weed control in maize and soybean. *Bulgarian Journal of Agricultural Science.* **22(1):** 52-59.

Shreshta, J., Timsina, K.P., Subedi, S., Pokhrel, D. and Chaudhary, A. (2019). Sustainable weed management in maize (*Zea mays* L.) production: A review in perspective of Southern Asia. *Turkish Journal of Weed Science.* **22(1):** 133-143.

Singh, A.K., Parihar, C.M., Jat, S.L., Singh, B. and Sharma, S. (2015). Weed management strategies in maize (*Zea mays* L.): Effect on weed dynamics, productivity and economics of the maize-wheat (*Triticum aestivum* L.) cropping system in Indo gangetic plains. *Indian Journal of Agricultural Sciences.* **85(1):** 87-92.

Singh, K., Kaur, T., Bhullar, M.S. and Brar, A.S. (2016). The critical period for weed control in spring maize in North-West India. *Maydica.* **61(1):** 7-10.

Soren, C., Chowdary, K.A., Sathish, G. and Patra, B.C. (2018). Weed dynamics and yield of *rabi* maize (*Zea mays* L.) as influenced by weed management practices. *Journal of Experimental Biology and Agricultural Sciences.* **6(1):** 150-158.

Sraw, P.K., Kaur, A. and Singh, K. (2016). Integrated weed management in *kharif* maize at farmers field in Central Punjab. *International Journal of Agricultural Science and Research.* **6(2):** 97-100.

Stanzen, L., Kumar, A., Puniya, R., Sharma, N., Sharma, A., Mahajan, A. and Chand Bana, R. (2017). Effect of tillage and weed management practices on weed dynamics and productivity in maize (*Zea mays* L.) wheat (*Triticum aestivum* L.) system. *International Journal of Current Microbiology and Applied Sciences.* **6(4):** 1907-1913.

Swetha, K., Madhavi, M., Prathiba, G. and Ramprakash, T. (2018). Weed growth, yield components, productivity, economics and nutrient uptake of maize (*Zea mays* L.) as influenced by various herbicide mixtures application under irrigated condition. *Environment and Ecology.* **36(1):** 103-111.

Takim, F.O., Fadayomi, O. and Ekeleme, F. (2014). Influence of cropping system and weed management practice on emergence, growth of weeds, yield of maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* L.). *Poljoprivreda.* **20(1):** 10-15.

Talebbeigi, R.M. and Ghadiri, H. (2012). Effects of cowpea living mulch on weed control and maize yield. *Journal of Biological and Environmental Sciences.* **6(17):** 189-193.

Triveni, U., Rani, Y.S., Patro, T.S.S.K. and Bharathalakshmi, M. (2017). Effect of different pre and post emergence herbicides on weed control, productivity and economics of maize. *Indian Journal of Weed Science.* **49(3):** 231-235.

Vidyashree, B.S., Arthanari, P.M. and Somasundaram, E. (2019). Effect of bio-mulches on weed flora on irrigated sunflower. *Journal of Pharmacognosy and Phytochemistry.* **8(3):** 441-443. www.indiastat.com.

Webber, C.L., Shrefler, J.W. and Taylor, M.J. (2008). Corn gluten meal as an alternative weed control option for spring transplanted onions. *International Journal of Vegetable Science.* **13(3):** 17-33.

Wuese, S.T., Agabi, E.T. and Ajon, A.T. (2018). Succeeding season effect of mulching on the performance of maize (*Zea mays* L.) in Makurdi, Nigeria. *Journal of Agriculture and Allied Sciences.* **7(2):** 450-456.

Yadav, R.K., Kumawat, N., Singh, A., Tomar, I.S., Singh, M. and Morya, J., Kumar, R and Upadhyay, P.K. (2018). Bio-efficacy of new herbicides in mixture and alone on weed dynamic, yields and nutrient uptake of maize (*Zea mays* L.) under rainfed conditions. *Indian Journal of Agricultural Sciences.* **88(4):** 1123-1128.

Yakadri, M., Rani, P.L., Prakash, T.R., Madhavi, M. and Mahesh, N. (2015). Weed management in zero till-maize. *Indian Journal of Weed Science.* **47(3):** 240-245.