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RESEARCH ARTICLE

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Effects of Intercropping on Plant Growth and Yield Performance of Toria (*Brassica campestris* L.) and Field Pea (*Pisum sativum* L.) under Irrigated Conditions

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ABSTARCT

Background: Intercropping with legumes improves resource use efficiency, soil N, soil quality, yields and profitability. Having deep root system, legumes can extract moisture and nutrients from deeper layer and hence does not compete with associated cereals. Therefore, intercropping particularly with leguminous crops is a sustainable option especially under adverse climatic conditions.

Methods: The experiment consisted of seven intercropping systems based on Sangam variety of Toria and Arkel variety of field pea *viz*., sole toria (T_1), sole field pea (T_2), toria + field pea, 3:3 (T_3), toria + field pea, 3:2 (T_4), toria + field pea, 3:1 (T_5), toria + field pea, 2:3 (T_6) and toria + field pea, 1:3 (T_7). All the treatments were arranged in RCBD and replicated four times.

Result: Findings of the present investigation showed that toria + field Pea-3:3 resulted maximum plant growth compared to minimum values of these attributes under sole cropping system. This system also resulted in highest number of siliqua per plant (215), siliqua length (6.9 cm), number of grain per siliqua (23.0) and test weight (4.6 g) of toria as well as maximum pods per plant (20.1), number of grains per pod (8.6) and test weight (56.4 g) of field pea. Improved plant growth and yield attributes finally reflected in terms of higher grain yield (12.0 and 10.6 q/h) and harvest index (32.1 and 44.7%) of both toria as well as field pea.

Key words: Field pea, Intercropping, Plant growth, Toria, Yield.

INTRODUCTION

Food security is a major challenge for agriculturist and policy makers as it's not just about feeding people but also concerned with economic and social aspects of the population. However, the accessibility of land for agriculture is shrinking day by day due to pressure in utilization for non-agricultural purposes (Roos *et al.* 2017). As such, agriculture has to produce more of farm products namely food, fodder, fuel and fiber for increasing human and animal needs of the populous world with limited available land for farming. One of the considerable strategies to increase agricultural output is intercropping systems (Maitra *et al*., 2021) that is a type of sustainable farming practice of growing two or more crops in the same field. The basic aim of intercropping is to produce greater yield per unit of land area through judicious use of resources like land, labour and other inputs. The system also provides insurance against total crop failure under unusual weather conditions or pest epidemics. Many studies confirmed the magnificent benefits of intercropping in terms of productivity and profitability, improvement of soil fertility, efficient use of resources, reducing damage caused by pests, diseases and weeds (Chalk, 1998; Javanmard *et al*., 2009; Dahmardeh *et al*., 2010). Choice of crops is important in intercropping, because severe competition in mixed culture may not be beneficial and even harmful if proper plant species are not chosen. The incorporation of legume in a cropping system is considered an ideal because it fixes atmospheric nitrogen that can be utilized by the sole crop. Different studies verified that cover legumes such as lablab, cowpea and vetch are highly effective in this regard (Ozpinar, 2009, Lemlem, 2013, Takim, 2012; Javanmard *et al*., 2009). In addition, legumes are also highly effective in conserving soil moisture and reducing soil erosion. The present investigation was performed to study the effect of intercropping toria and field pea on their vegetative growth and yield.

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MATERIALS AND METHODS

The present experiment was conducted during the *Rabi* season of 2018-2019 at Himgiri Zee University, Dehradun.

(Uttarakhand). The experimental site is situated at 300 20′20″N latitude and 770 52′33″E longitude at a height of 450 meters above the means sea level. The experimental area is characterized by sub-tropical and rain fed type of climate with hot and dry (March to June), hot and humid (July to September) and cold winter (November to January) weather. The average annual rainfall at Dehradun is 1896 mm, most of which is received during June to October. The soil available N, P and K of the experimental field were 189.04, 24.75 and 158.8 kg.ha^{-1}, respectively with pH, EC and OC level of 7.6, 0.23 dS m^{-1} and 0.59%, respectively.

Using Sangam variety of Toria and Arkel variety for Field pea, the experiment was laid out in randomized complete block design (RCBD) with seven treatments and four replications. The treatments were sole toria (T_1), sole field pea (T_2), toria + field pea, 3:3 (T_3), toria + field pea, 3:2 (T_4), toria + field pea, 3:1 (T_5), toria + field pea, 2:3 (T_6) and toria + field pea, 1:3 (T_7). The net plot size of the experimental field was 3.4 × 4.2 m. Half of the recommended dose of N and full dose of P and K in the form of urea, DAP and MOP were applied as basal while rest dose of nitrogen applied after irrigation during pre-flowering period. Standard cultural and plant protection measures were adopted. Harvesting of both the crops was done after physiological maturity.

Plant height, number of leaves, dry matter accumulation and number of branches were recorded for both the crops at 30 DAS, 60 DAS and/or at harvest. Number of siliqua plant^{-1}, length of siliqua (cm), number of seed siliqua^{-1}, 1000-grain weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%) were recorded for toria. Likewise, number of pod plant^{-1}, number of seeds pod^{-1}, seed index (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%) were also recorded for field pea. The data recorded were analyzed statistically using randomized complete block design described by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Perusal of the data presented in Table 1 reflects that sole cropping of toria as well as field pea resulted in smaller plant height compared to their intercropping systems with different proportions of rows. Sole cropping of toria (T_1) produced a plant height of 30.6, 86.9 and 91.6 cm while as the plant height of field pea under sole cropping (T_2) was 18.5, 32.2 and 48.4 cm at 30 DAS, 60 DAS and harvest, respectively. Intercropping of toria + field pea with a ratio of 3:3 rows (T_3) produced highest plant height of both toria (41.6, 111.2 and 114.4 cm) as well as field pea (25.7, 37.7 and 53.4 cm) at all the stages, respectively that were statistically at par with the intercropping of toria + field pea with a ratio of 3:2 rows (T_4) significantly followed by toria + field pea with a ratio of 2:3 rows (T_6). Conforming results have also been reported by Feng *et al.* (2019). Variation in plant height may be attributed to varied light interception altered nutrient use efficiency under intercropping system (Walley *et al.,* 2007).

So far as number of branches is concerned (Table 2) sole cropping produced lesser number of branches (5.2, 7.7 and 9.3; 5.09, 6.6 and 9.1) both in toria (T_1) as well as in field pea (T_2) counted at 30 DAS, 60 DAS and harvest stages, respectively. The maximum number of branching in toria (7.0, 11.1 and 13.7) as well as in field pea (6.6, 8.7 and 11.4) at referred stages was recorded with intercropping of toria + field pea with a ratio of 3:3 rows (T_3) which was statistically at par with intercropping of toria + field pea with a ratio of 3:2 rows (T_4) but significantly followed by intercropping system of toria + field pea with a ratio of 2:3 rows (T_6). Our results corroborate the findings of Mwamlima *et al* (2016). Increased branching might have resulted due to the available spacing and light incidence (Chen and Sumida, 2018) as well as nutrients from the soil (Edgar *et al.,* 2017).

Data (Table 3) indicated that number of leaf per plant under sole cropping of toria (11.8 and 34.3) as well as field pea (27.6 and 52.4) was lowest at both 30 and 60 DAS compared to their counter intercropping systems with different row ratio. At 30 DAS toria with intercropping of toria + field pea with a row ratio of 1:3 (T_7) gave the maximum number of leaf (16.1) and at 60 DAS the maximum number of leaf (45.6) was recorded with toria + field pea with a row ratio of 3:3 (T_3). However, in case of field pea intercropping of toria + field pea with a ration of 3:3 (T_3) resulted in maximum number of leaf both at 30 DAS (32.5) as well as 60 DAS (64.8). The highest number of leaf in T_3 at 60 DAS

Table 1: Effect of intercropping on plant height of toria and field pea taken as component crops.

Intercropping system	Plant height (cm)					
	Toria			Field pea		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1- Sole toria	30.6	86.9	91.6	-	-	-
T_2- Sole field pea	-	-	-	18.5	32.2	48.4
T_3- Toria + Field pea (3:3)	41.6	111.2	114.4	25.7	37.7	53.4
T_4- Toria + Field pea (3:2)	36.8	107.8	108.4	23.3	36.4	52.1
T_5- Toria + Field pea (3:1)	31.8	97.1	102.9	22.4	33.8	50.4
T_6- Toria + Field pea (2:3)	33.6	104.0	105.2	22.9	35.6	51.9
T_7- Toria + Field pea (1:3)	32.4	92.0	95.7	19.9	32.7	50.1
S.E. (d)	1.7	2.9	4.05	0.9	0.4	0.6
CD (0.05)	5.2	8.6	11.2	2.8	1.4	2.0

in both the crops was found statistically at par with intercropping of toria + field pea with a ration of 3:2 (T_4) but was significantly followed by all other intercropping.

Dry weight of toria and field was found minimum under sole cropping systems with absolute values of 2.2 and 8.4 g/plant (toria-T_1) and 0.4 and 5.5 g/plant (field pea - T_2), respectively at 30 and 60 DAS. However, toria + field pea 3:3 (T_3) recorded maximum plant dry weight of toria (2.9 and 12.4 g/plant) and field pea (0.6 and 8.2 g/plant) at both 30 and 60 DAS, respectively followed by toria + field pea with a row ratio of 3:1 (T_5) with dry weight of 2.4 and 9.8 g/plant in toria and 0.4 and 6.9 g/plant in field pea, respectively. Different intercropping system enable the plant to have variable efficiency of light as well as soil nutrient utilization (Portes and Melo, 2014.) which results in varied leaf area that ultimately influenced the biomass production. The increased leaf number might be due to the enhanced number of branches (Edgar *et al.,* 2017).

Observations regarding various yield components of toria and field pea presented in Table 4 indicate that toria as sole crop (T_1) exhibited lowest number of Siliqua (109/plant), length of siliqua (5.5 cm), number of grain (17.8/siliqua) and test weight (4.1 g). Similarly field peas as sole crop (T_2) also displayed least number of pods per plant (14.9), grains per pod (3.8) and test weight (32.1 g). However, toria + field pea with a row ratio of 3:3 (T_3) resulted in highest number of siliqua per plant (215), length of siliqua (6.9 cm), number of grain per siliqua (23.0) and test weight (4.6 g) of toria together with highest number of pods per plant (20.1), grains per pod (8.6) and test weight (56.4 g) of field pea. Toria + field pea with a row ratio of 1:3 (T_7) exhibited lest values of the attributes with respect to both toria and field pea. However, differences in test weight of field pea were non-significant with regard to various intercropping systems. In agreement with our findings Banik *et al*. (2008) also informed that legume intercropping with toria with different arrangement of row spacing significantly influenced the different yield components. Conforming results have also been reported by Subedi (1997) and Tuti *et al*. (2012).

Dry matter partitioning in terms of grain and stover yield, and crop harvest index of toria and field pea under various intercropping system presented in Fig 1 revealed that grain and straw yield of toria crop varied significantly with different intercropping system. The highest grain yield of toria (12.0 q/ha) was recorded in toria + field pea with 3:3 row ratio (T_3) that was statistically at par with sole crop of toria with grain yield of 11.9 q/ha. Inversely, the highest stover yield of toria (27.5 q/ha) was recorded with sole toria crop (T_1) followed by intercropping system of toria + field pea with 3:3 row ratio (T_3) with stover yield of 25.4 q/ha. However, differences

Table 2: Effect of intercropping on number of branches per plant of toria and field pea taken as component crops.

Intercropping system	No. of branches per plant					
	Toria			Field pea		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1- Sole toria	5.2	7.7	9.3	-	-	-
T_2- Sole field pea	-	-	-	5.09	6.6	9.1
T_3- Toria + Field pea (3:3)	7.0	11.1	13.7	6.6	8.7	11.4
T_4- Toria + Field pea (3:2)	6.4	10.2	12.8	6.1	8.3	10.6
T_5- Toria + Field pea (3:1)	6.2	8.8	10.5	5.3	6.9	9.1
T_6- Toria + Field pea (2:3)	5.5	9.1	11.8	5.6	7.1	9.6
T_7- Toria + Field pea (1:3)	6.2	8.7	10.4	5.2	6.8	8.9
S.E. (d)	0.3	0.4	0.31	0.2	0.1	0.3
CD (0.05)	1.07	1.2	0.93	0.7	0.5	0.9

Table 3: Effect of intercropping on number of leaf per plant of toria and field pea taken as component crops.

Intercropping system	No. of leaf per plant				Plant dry weight (g/plant)			
	Toria		Field pea		Toria		Field pea	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T_1- Sole toria	11.8	34.3	-	-	2.2	8.4	-	-
T_2- Sole field pea	-	-	27.6	52.4	-	-	0.4	5.5
T_3- Toria + Field pea (3:3)	14.4	45.6	32.5	64.8	2.9	12.4	0.6	8.1
T_4- Toria + Field pea (3:2)	14.3	45.3	29.6	64.5	2.8	11.5	0.5	7.5
T_5- Toria + Field pea (3:1)	14.5	40.8	28.6	56.6	2.4	9.8	0.4	6.9
T_6- Toria + Field pea (2:3)	15.2	42.9	29.0	59.6	2.7	11	0.5	7.1
T_7- Toria + Field pea (1:3)	16.1	35.7	28.4	54.3	2.5	9.6	0.4	6.3
S.E. (d)	0.7	0.11	1.02	0.10	0.14	0.37	0.05	0.2
CD (0.05)	2.3	0.33	3.06	0.31	0.43	1.11	0.1	0.8

Table 4: Effect of intercropping on yield related attributes of toria and field pea taken as component crops.

Intercropping system	Yield components						
	Toria				Field pea		
	Siliqua per plant	Siliqua length (cm)	No. of grains per siliqua	Test weight (g)	No. of Pods per plant	No. of grains per pod	Test weight (g)
T_1- Sole toria	109	5.5	17.8	4.1	-	-	-
T_2- Sole field pea	-	-	-	-	14.9	3.8	32.1
T_3- Toria + Field pea (3:3)	215	6.9	23.0	4.6	20.1	8.6	56.4
T_4- Toria + Field pea (3:2)	194	6.5	21.4	4.3	19.2	6.9	52.9
T_5- Toria + Field pea (3:1)	185	5.9	19.5	4.2	16.6	4.9	51.7
T_6- Toria + Field pea (2:3)	186	6.1	20.7	4.2	17.8	5.9	53.4
T_7- Toria + Field pea (1:3)	125	5.5	18.2	4.1	15.8	4.1	48.6
S.E. (d)	20.03	0.05	0.8	0.04	0.6	0.6	3.7
CD (0.05)	60.3	0.1	2.5	0.1	2.09	1.8	NS

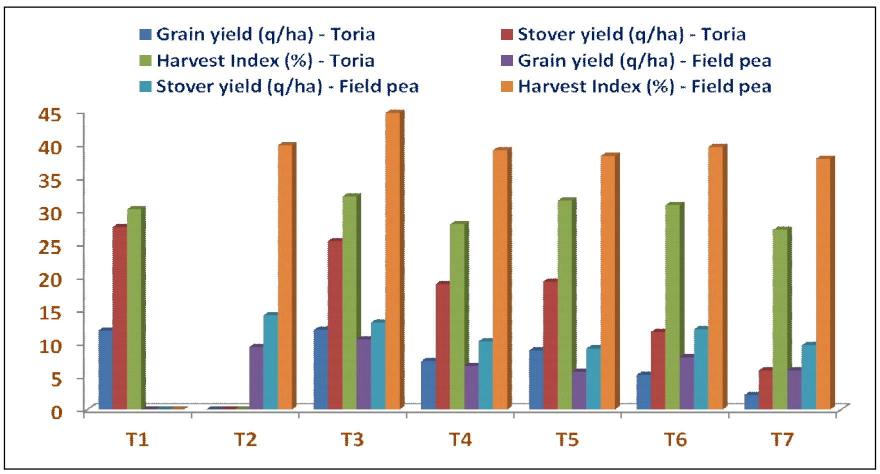

Fig 1: Effect of intercropping on yield and harvest index of toria and field pea taken as component crops.

among the various intercropping systems with respect to harvest index of toria were non-significant. In case of field pea, the highest grain (10.6 q/ha) and stover (14.2 q/ha) yield were recorded with toria + field pea with 3:3 row (T_3) and sole field pea (T_1) cropping, respectively followed in vice versa. However, unlike toria, the harvest index of field was differed significantly among various intercropping treatments and toria + field pea with 3:3 row (T_3) recorded the highest HI (44.7%) followed by sole field pea (T_2) with minimum HI of 37.8% in toria + field pea sown in line with 1:3 ratio (T_7). Variations in grain and stover yield among different intercropping systems of field pea and toria may be attributed to varied growth dimensions of component crops under different intercropping systems as plant vegetative growth has direct relationship with grain yield and quality (Bechem *et al.*, 2018). Potential yields of tori as well as field pea might be the result of progressively accumulated photosynthesis partitioned to different yield components as a result of good source-sink relationship (Mangi *et al.*, 2021). In addition, grain yield of tori and field pea, just like yields of most crops, is a manifestation of various growth and yield attributing characteristics (Al-Suhaibani *et al.*, 2016).

CONCLUSION

Findings of the present study indicated that intercropping of toria + field pea is better in terms of both plant growth as well as yield attributes than growing of these crops individually. Further, Toria + field pea in a proportion of 3:3 rows resulted maximum plant growth, grain yield and harvest index than other intercropping systems. However, before recommending to the farmers, the system needs to be verified in the farmer's field under the careful scientific monitoring.

Conflict of interest: None.

REFERENCES

Al-Suhaibani, N., El-Hendawy, S. and Schmidhalter, U. (2016). Influence of varied plant density on growth, yield and economic return of irrigated faba bean (*Vicia faba* L.). Turkish Journal of Field Crops. 18(2): 185-197.

Banik, P., Sasmal, T., Ghosal, P.K. and Bagchi D.K. (2008). Evaluation of mustard (*Brassica compestris* Var. Toria) and legume intercropping under 1: 1 and 2: 1 row-replacement series systems. Journal of Agronomy and Crop Science. 14: 9-14.

Bechem, E.E., Ojong, A.N. and Etchu, K.A. (2018). The effects of intercropping and plant densities on growth and yield of maize (*Zea mays* L.) and soybean (*Glycine max*) in the humid forest zone of Mount Cameroon. African Journal of Agricultural Research. 13 (12): 574-587.

Chalk, P.M. (1998). Dynamics of biologically fixed N in legume-cereal rotations: A review. Australian Journal of Agricultural Research. 49(3): 303-316.

Chen, L. and Sumida, A., (2018). Effects of light on branch growth and death vary at different organization levels of branching units in Sakhalin spruce. Trees, 32: 1123-1134.

Cochran, WG. and Cox, DR. (1957). Experimental Designs (Second Edition). John Wiley and Sons, New York.

Dahmardeh, M., Ghanbari, A., Syahsar, B.A. and Ramrodi, M. (2010). The role of intercropping maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* L.) on yield and soil chemical properties. African Journal of Agricultural Research. 5(8): 631-636.

Edgar, O.N., Gweyi-Onyango, J.P. and Korir, N.K. (2017). Plant row spacing effect on growth and yield of green pepper (*Capsicum annuum* L.) in Western Kenya. Archives of Current Research International. 7(3): 1-9.

Feng, L., Raza, M.A., Chen, Y., Khalid, M.H.B., Meraj, T.A., Ahsan, F., Fan, Y., Du, J., Wu, X., Song, C., Liu, C., Bawa, G., Zhang, Z., Yuan, S., Yang, F. and Yang, W. (2019). Narrow-wide row planting pattern improves the light environment and seed yields of intercrop species in relay intercropping system. PLoS One. 14(2): 1-19.

Javanmard, A., Nasab, A.D.M., Javanshir, A., Moghaddam, M. and Janmohammadi, H. (2009). Forage yield and quality in intercropping of maize with different legumes as double-cropped. Journal of Food Agricultural and Environmental Science. 7(1): 163-166.

Lemlem, A. (2013). The effect of intercropping maize with cowpea and lablab on crop yield. Herald Journal of Agriculture and Food Science Research. 2(5): 156-170.

Maitra, S., Hossain, A., Brestic, M., Skalicky, M., Ondrisik, P., Gitari, H., Brahmachari, K., Shankar, T., Bhadra, P., Palai, J.B., Jena, J., Bhattacharya, U., Duvvada, S.K., Lalichetti, S. and Sairam, M. (2021). Intercropping-Alow input agricultural strategy for food and environmental security. Agronomy. 11: 343.

Mangi, N.; Nazir, M.F.; Wang, X.; Iqbal, M.S.; Sarfraz, Z.; Jatoi, G.H., Mahmood, T.; Ma, Q.; Shuli, F. (2021). Dissecting Source-Sink Relationship of Subtending Leaf for Yield and Fiber Quality Attributes in Upland Cotton (*Gossypiumhirsutum* L.). Plants. 2021, 10, 1147. https://doi.org/ 10.3390/ plants10061147.

Mwamlima, L.H., Kabambe, V.H., Mhango, W.G., ,Nyirenda, G.K.C. (2016). Effects of intercropping on growth and yield of intercropped cotton (*Gossypium hirsutum*) and cowpea (*Vigna unguiculata* L. Walp) in Malawi. Agricultural Science. Research Journal. 6 (12): 303-312.

Ozpinar, S. (2009). Tillage and cover crop effects on maize yield and soil nitrogen. Bulgarian Journal of Agricultural Science. 15(6): 533-543.

Portes, T.A. and Melo, H.C. (2014). Light interception, leaf area and biomass production as a function of the density of maize plants analyzed using mathematical models. Acta Scientiarum Agronomy. 36(4): 457-463.

Roos, E., Bajzelj, B., Smith, P. Patel, M., Little, D. and Garnett, T. (2017). Greedy or needy? Land use and climate impacts of food in 2050 under different livestock futures. Global. Environmental Chang. 47: 1-12

Subedi, K.D. (1997). Wheat intercropped with tori (*Brassica campestris* var. toria) and pea (*Pisum sativum*) in the subsistence farming system of the Nepalese hills. Journal of Agricultural Science (Cambridge). 128: 283-289.

Takim, F.O. (2012). Advantages of maize-cowpea intercropping over sole cropping through competition indices. Journal of Agriculture and Biodiversity Research. 1(4): 53-59.

Tuti, M.D., Mahanta, D., Mina, B.L., Bhattacharyya, R., Bisht, J.K. and Bhatt, J.C. (2012). Performance of lentil (*Lens culinaris*) and toria (*Brassica campestris*) intercropping with wheat (*Triticum aestivum*) under rainfed conditions of north-west Himalaya. Indian Journal of Agricultural Sciences. 82 (10): 841-844.

Walley, F.L., Clayton, G.W., Miller, P.R.., Carr, P.M. and Lafond, G.P. (2007). Nitrogen economy of pulse crop production in the Northern Great Plains. Agron. J. 99: 1710-1718.