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Effects of Genotypic Diversity on Insect-pests of Soybean

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ABSTRACT

Background: Intercropping and mixed cropping based on two or more different crops have been widely used in Insect Pest Management to manage the population density of insect pests in various crops like maize with soybean, sorghum with soybean and sunflower with soybean. Genotypic diversity is the mixture or combination of various varieties/lines/genotypes of a crop. It decreases the insect-pests population by unfitness of crop to them due to intraspecific diversity such as mixture of susceptible and resistant varieties. Also, it increases the natural enemy population more due to longer period of flowering, availability of wide diverse food, more movement of herbivores *etc*. This concept has also been used successfully to manage insect-pests in maize, wheat and potato. In India, this connect is used in very small scale in crop. The objective of this study was to determine effects of genotypic diversity by comparing the population densities of major insect pests between monoculture of single variety and mixture of varieties.

Methods: To test the effects of genotypic diversity on soybean insect-pest and their natural enemy population an experiment was laid in *kharif* 2018 and 2019 at the ICAR-Indian Institute of Soybean Research, Indore. All recommended agronomic package of practices were followed for raising of crop. Randomized block design with three replication having plot size of 9 rows of 5 meter row length was used. Totally 20 treatments were chosen for this experiment and out of 20 four treatments namely, T1, T6, T11 and T16 were the treatments of four varietal mixture treatments of almost similar maturity duration and agronomic traits and rest of treatments were of sole varietal treatments. Observations were made on insect-pests from 10 selected plants in each plot on three leaves selected at top, middle and lower portion of plant.

Result: Effects of genotypic diversity in soybean revealed that for whitefly management T11 (NRC-86, JS-335, JS-2098 and RKS-45) was found most effective treatment. In case of mite, thrips and treehoppers management T1 (JS-9560, JS-20-34, MAUS-47 and MAUS-1460) was found most effective treatment. For leafhopper and mealy bug T6 (JS-9305, JS-2029, RVS-2001-4 and Dsb-28-3) was found most effective treatment. While for spittlebug T16 (NRC-37, JS-9752, RSC-1046 and RKS-113) was found most effective treatment. So, genotypic diverse treatments were found more effective than their respective sole varietal treatments.

Key words: Genotypic diversity, Natural enemies, Sole variety, Soybean insect-pests, Varietal mixture.

INTRODUCTION

Intercropping and mixed cropping based on two or more different crops have been widely used in Insect Pest Management programme to manage the population density of insect pests in various crops like maize with soybean, sorghum with soybean and sunflower with soybean (Martin *et al*., 1989; Holmes and Barrett, 1997; Michaud *et al*., 2007; Sujyanand *et al*., 2021; Parthiban *et al*., 2017). Genotypic diversity is the mixture or combination of various varieties/ lines/genotypes of a crop. It can be used in insect- pests management to control them effectively by various ways. Mixing of two or three even four varieties can alter the behaviour of insect-pests as well as natural enemies. Growing of continuously one variety make it susceptible to insect-pests attack because it is allowing insect pests to move and infest crop easily from field to field even area to area and destroy crop fields. Genotypic diversity decreases the insect-pests population by unfitness of crop to them due to intraspecific diversity such as mixture of susceptible and resistant varieties. Also, it increases the natural enemy population more due to longer period of flowering, availability of wide diverse food, more movement of herbivores *etc*. Mixed cropping based on the varietal mixture of a crop is new and recently used concept in various crops like rice, maize, wheat and to some extent in soybean across the world. This concept has also been used successfully used to manage insect-pests in maize, wheat and potato (Power, 1988, 1991; Cantelo and Sanford, 1984; Shoffner and Tooker, 2013). In India, this connect is used in very small scale in crop. Genotypically diverse mixture also increase movement of insect herbivores, decreasing acquisition and transmission of persistent viruses like yellow mosaic virus in whitefly which require longer period of feeding to acquire and transmission of virus to new host plants (Kennedy and Kishaba 1977; Power 1991). Varietal mixtures can improve insect pest control of many insect species, mainly hemipterans insects like aphids that share attributes of pathogens. These attributes include patterns of short and

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long range dispersal, size of populations of first colony in the field, the narrow degree of host plant specialization, short generation times and induction of host plant defenses often triggered by salicylic acid (Orlob, 1961; Wilhoit, 1992; Garrett and Mundt, 1999; Walling, 2000; Castro, 2001; Merrill, *et al.,* 2009). The objective of this study was to determine effects of genotypic diversity by comparing the population densities of major insect pests between monoculture of single variety and mixture of varieties.

MATERIALS AND METHODS

To test the effects of genotypic diversity on soybean insect-pest population 20 treatments were chosen. The treatments of T1, T6, T11 and T16 included the treatments of varietal mixture treatments. These varietal mixtures were made of four varietal mixtures of almost similar maturity duration and agronomic traits. Each variety of each mixture was also grown separately to compare the effects of varietal mixture to sole variety of their respective mixtures. For varietal mixture treatment preparation equal quantity of each variety seed was taken and mixed well before sowing.

Techniques/Methodology

The experiment was laid in *kharif* 2018 and 2019 at the ICAR-Indian Institute of Soybean Research, Indore (Madhya Pradesh). All recommended agronomic practices were followed for raising of crop. Randomized block design with three replication having plot size of 9 rows of 5 meter length was used. The distance between rows, plots and replications was 0.45 meter, 1meter and 1.5 meter, respectively. To avoid the border effects border rows were excluded for taking of observations. For whitefly observations 10 plants were selected in each plot and in each plant three leaves were selected at upper, middle and lower positions. For observations on lepidopteran pests' total number of larvae per meter rows was counted at three places randomly in each plot. For stem fly observations percent stem tunneling per plant was taken on five plants randomly selected in each plot and for girdle beetle number of infested and damaged plants per plot were observed randomly at five places in each plot. In case of natural enemies 1m^2 area was selected randomly at three different places in each plot and population of natural enemies was counted.

Statistical analysis and data transformations

Randomized block design with three replications was used for raising of soybean crop. For statistical analysis all the raw data was transformed. For count data like whitefly, leafhopper, spiders *etc*. square root transformation was used and for percent data like stem fly, girdle beetle *etc.* angular transformation was used.

RESULTS AND DISCUSSION

Effects of genotypic diversity on insect-pests of soybean

During *Kharif* 2018

The insect-pests population of soybean as influenced by genotypic diversity during *kharif* 2018 is presented in Table 1.

The population density of all the seven insect-pests namely, whitefly, mite, leafhopper, thrips, mealy bug, tree hopper and spittle bug in all the varietal mixture treatments was found lower than their respective sole varietal treatments except in whitefly where T16 (2.7/leaf) was found on par with T19 (2.7/leaf).

The population density of whitefly in all the treatments ranged between 2.1- 5.1 per leaf. The lowest whitefly population density was found in T6 (Mixture of JS-9305, JS-2029, RVS-2001-4 and Dsb-28-3) (2.63/leaf) followed by T11 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45) (2.40/leaf).

The population density of mite was ranged between 6.6-17.4 per leaf. The lowest population density of mite was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) (6.6/leaf) followed by T6 (Mixture of JS-9305, JS-2029, RVS-2001-4 and Dsb-28-3) (7.5/leaf).

The population density of leafhopper ranged between 3.0- 14.1 per leaf. In case of leafhopper management, the lowest population density was found in T6 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T11 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45) with population of 3.0 and 3.9 per leaf, respectively.

The population density of thrips ranged between 0.6-3.3 per leaf. The lowest thrips population density was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T16 (Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) with population of 0.6 and 0.9 thrips per leaf, respectively.

The population density of mealy bug ranged between 1.1- 4.1 per plant. The lowest mealy bug population density was found in T16 (Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) followed by T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) with 1.1 and 1,2 per plant, respectively.

The population density of tree hopper ranged between 0.7- 2.2 per plant. The lowest tree hopper population density was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) (2.63) followed by T11 **(**Mixture of NRC-86, JS-335, JS-2098 and RKS-45) and T16 (Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) with population of 0.7, 0.8 and 0.8 per plant, respectively which were at par with each other.

The population density of spittle bug ranged between 0.7- 1.9 per leaf. The lowest spittle bug population density was found in T16 (Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) (0.7 per plant) followed by T6 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) (0.8 per plant).

During *Kharif* 2019

The insect pest population of soybean as influenced by genotypic diversity during *kharif* 2019 is presented in Table 2.

The population density of all the seven insect-pests namely, whitefly, mite, leafhopper, thrips, mealy bug, tree hopper and spittle bug in all the varietal mixture treatments was found lower than their respective sole varietal treatments except in whitefly, mite, treehopper and spittle bug. In case of whitefly T16 (3.37/leaf) recorded higher population density than T17 (3.20/leaf) and T18 (3.30/leaf), respectively. Likewise, in case of mite and tree hopper, T11 sustained higher population density (9.80 mites/leaf) and (1.37 treehoppers/plant) than T15 (9.47 mites/leaf) and (1.20 treehoppers/plant), respectively. In case of spittle bug, T1 recorded higher population density (1.23/plant) than T2 (1.13/plant) and T5 (1.13/plant), respectively and the latter two treatments were at par with each other.

The population density of whitefly ranged between 2.63-5.77 per leaf. The lowest whitefly population density was found in T11 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45) (2.63/leaf) followed by T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) (3.13/leaf).

The population density of mite ranged between 6.03-16.57 per leaf. The lowest population density of mite was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T6 (Mixture of JS-9305, JS-2029, RVS-2001-4 and Dsb-28-3) with population of 6.6 and 7.5 per leaf, respectively.

The population density of leafhopper ranged between 3.03- 12.87 per leaf. In case of leafhopper management, the lowest population density was found in T6 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T11 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45 with population of 3.03 and 5.57 per leaf, respectively.

The population density of thrips ranged between 0.63-3.0 per leaf. The lowest thrips population density was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T6 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45) with population of 0.63 and 1.27 per leaf, respectively.

The population density of mealy bug ranged between 1.13- 3.97 per plant. The mealy bug population density was found lowest in T6 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) followed by T16 (Mixture of NRC-37,

Table 1: Effects of genotypic diversity on insect-pests of soybean (2018).

Treatment	Whitefly /leaf	Mite /leaf	Leaf hopper / leaf	Thrips /leaf	Mealy bug / plant	Tree hopper / plant	Spittle bug /plant
T1- Mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460	2.7 (1.79)	6.6 (2.66)	5.7 (2.49)	0.6 (1.05)	1.2 (1.30)	0.7 (1.10)	0.9 (1.18)
T2- JS-9560	3.6 (2.02)	9.3 (3.13)	8.1 (2.93)	2.7 (1.79)	3.7 (2.05)	1.3 (1.34)	1.2 (1.30)
T3- JS-20-34	3.9 (2.10)	12.0 (3.54)	9.9 (3.22)	2.4 (1.70)	3.9 (2.10)	1.1 (1.26)	1.3 (1.34)
T4- MAUS-47	3.3 (1.95)	11.7 (3.49)	12.6 (3.62)	3.0 (1.87)	2.7 (1.79)	1.4 (1.38)	1.4 (1.38)
T5- MAUS-1460	3.0 (1.87)	8.8 (3.05)	10.2 (3.27)	2.1 (1.61)	2.1 (1.61)	1.9 (1.55)	1.0 (1.22)
T6- Mixture of JS-9305, JS-2029, RVS-200 1-4 and Dsb-28-3	2.1 (1.61)	7.5 (2.83)	3.0 (1.87)	1.2 (1.30)	1.3 (1.34)	1.0 (1.22)	0.8 (1.14)
T7- JS-9305	4.5 (2.24)	11.1 (3.41)	11.4 (3.45)	2.4 (1.70)	4.1 (2.14)	2.1 (1.61)	1.7 (1.48)
T8-JS-2029	3.9 (2.10)	15.3 (3.97)	9.3 (3.13)	2.4 (1.70)	2.3 (1.67)	1.6 (1.45)	1.9 (1.55)
T9- RVS-2001-4	3.6 (2.02)	12.9 (3.66)	14.1 (3.82)	2.1 (1.61)	3.1 (1.90)	1.4 (1.38)	1.3(1.34)
T10- Dsb-28-3	3.6 (2.02)	12.6 (3.62)	7.5 (2.83)	1.8 (1.52)	3.0 (1.87)	1.7 (1.48)	1.5 (1.41)
T11- Mixture of NRC-86, JS-335, JS-2098 and RKS-45	2.4 (1.70)	8.9 (3.07)	3.9 (2.10)	1.5 (1.41)	1.5 (1.41)	0.8 (1.14)	0.9 (1.18)
T12- NRC-86	5.1 (2.37)	13.5 (3.74)	6.6 (2.66)	2.7(1.79)	2.8 (1.82)	1.8 (1.52)	1.3 (1.34)
T13- JS-335	3.3 (1.95)	10.8 (3.36)	8.7 (3.03)	3.3 (1.95)	2.5 (1.73)	2.1 (1.61)	1.2 (1.30)
T14- JS-2098	4.2 (2.17)	11.4 (3.45)	10.5 (3.32)	3.0 (1.87)	1.9 (1.55)	1.7 (1.48)	1.1 (1.26)
T15- RKS-45	3.0 (1.87)	9.3 (3.13)	8.4 (2.98)	2.1 (1.61)	3.1 (1.90)	1.3 (1.34)	1.7 (1.48)
T16- Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113	2.7 (1.79)	8.4 (2.98)	5.4 (2.43)	0.9 (1.18)	1.1 (1.26)	0.8 (1.14)	0.7 (1.10)
T17- NRC-37	3.0 (1.87)	9.0 (3.08)	7.5 (2.83)	2.7 (1.79)	3.5 (2.00)	2.0 (1.58)	1.5 (1.41)
T18- JS-9752	3.3 (1.95)	13.2 (3.70)	12.3 (3.58)	3.3 (1.95)	2.7 (1.79)	2.2 (1.64)	1.3 (1.34)
T19- RSC-1046	2.7 (1.79)	12.6 (3.62)	6.9 (2.72)	3.0 (1.87)	2.2 (1.64)	1.8 (1.52)	1.1 (1.26)
T20- RKS-113	3.6 (2.02)	17.4 (4.23)	9.3 (3.13)	2.1 (1.61)	2.8 (1.82)	1.6 (1.45)	1.7 (1.48)
S.Em.±	**0.06**	**0.31**	**0.22**	**0.17**	**0.13**	**0.12**	**0.13**
C.D. at 5%	**0.13**	**0.60**	**0.44**	**0.34**	**0.26**	**0.24**	**0.26**
C.V. (%)	**3.98**	**11.27**	**8.93**	**12.67**	**9.24**	**10.48**	**11.95**

(Figures in the parentheses are square root transformations).

JS-9752, RSC-1046 and RKS-113) with population of 1.13 and 1.37 per plant, respectively.

The population density of tree hopper ranged between 0.90- 2.67 per plant. The lowest tree hopper population density was found in T1 (mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460) (2.63/leaf) followed by T16 **(**Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) with population of 0.9 and 0.93 per plant, respectively.

The population density of spittle bug ranged between 0.70- 1.97 per plant. The lowest spittle bug population density was found in T11 (Mixture of NRC-86, JS-335, JS-2098 and RKS-45) followed by T16 (Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113) with population of 0.7 and 0.77 per plant, respectively.

All these results indicate that decreasing trends of insect-pests have been found in genotypic diverse treatments as compared to monocropping of single variety. These results are in line with the reports of Risch (1981); Letourneau (1987) and Peacock and Herrick (2000). The reasons behind this were that in diverse cultivar mixtures each variety has a different level of resistance against different insects (Nault *et al.* 1992; Costa *et al*. 2014). Mixing of two oat varieties found lesser population of aphid and likewise mixing of five varieties of corn found lesser population of leafhopper significantly than growing of single variety (Power 1988, 1991). Mixing of susceptible variety with resistant variety in potato resulted in lesser population of potato leafhopper (Cantelo and Sanford 1984). So, this provide uncomfortable climate for multiplication of herbivores. Also, diverse varietal mixture provides suitable climate for multiplication of natural enemies which control the herbivores population lower than sole variety treatments. There had been 56% more abundance and 80% more diversity of parasitoids in genotypic diverse mixture than monocropping of single variety (Jones *et al*., 2011).

Table 2: Effects of genotypic diversity on insect-pests of soybean (2019).

Treatment	Whitefly /leaf	Mite /leaf	Leaf hopper / leaf	Thrips /leaf	Mealy bug / plant	Treehopper /plant	Spittlebug /plant
T1- Mixture of JS-9560, JS-20-34, MAUS-47 and MAUS-1460	3.13 (1.91)	6.03 (2.56)	5.93 (2.54)	0.63 (1.06)	1.57 (1.44)	0.90 (1.18)	1.23 (1.32)
T2- JS-9560)	3.67 (2.04)	8.60 (3.02)	8.53 (3.01)	2.47 (1.72)	3.50 (2.00)	1.40 (1.38)	1.13 (1.28)
T3- JS-20-34	4.17 (2.16)	11.17 (3.42)	9.90 (3.22)	2.13 (1.62)	3.87 (2.09)	1.37 (1.37)	1.37 (1.37)
T4- MAUS-47	3.97 (2.11)	10.37 (3.30)	11.87 (3.52)	2.70 (1.79)	2.73 (1.80)	1.83 (1.53)	1.43 (1.39)
T5- MAUS-1460	3.40 (1.97)	8.47 (2.99)	10.20 (3.27)	2.03 (1.59)	2.13 (1.62)	1.87 (1.54)	1.13 (1.28)
T6- Mixture of JS-9305, JS-2029, RVS-2001-4 and Dsb-28-3	3.47 (1.99)	7.63 (2.85)	3.03 (1.88)	1.27(1.33)	1.13 (1.28)	1.23 (1.32)	0.97 (1.21)
T7- JS-9305	4.83 (2.31)	11.57 (3.47)	12.87 (3.66)	2.40 (1.70)	3.97 (2.11)	2.13 (1.62)	1.83 (1.53)
T8-JS-2029	4.23 (2.18)	14.97 (3.93)	9.37 (3.14)	2.40 (1.70)	2.40 (1.70)	1.67 (1.47)	1.97 (1.57)
T9- RVS-2001-4	4.07 (2.14)	13.30 (3.71)	13.93 (3.80)	2.13 (1.62)	3.93 (2.11)	1.53 (1.43)	1.40 (1.38)
T10- Dsb-28-3	3.90 (2.10)	12.40 (3.59)	8.73 (3.04)	1.67 (1.47)	2.97 (1.86)	1.80 (1.52)	1.57 (1.44)
T11- Mixture of NRC-86, JS-335, JS-2098 and RKS-45	2.63 (1.77)	9.80 (3.21)	5.57 (2.46)	1.57 (1.44)	1.63 (1.46)	1.37 (1.37)	0.70 (1.10)
T12- NRC-86	5.77 (2.50)	13.53 (3.75)	7.73 (2.87)	2.30 (1.67)	3.00 (1.87)	1.77 (1.51)	1.17 (1.29)
T13- JS-335	4.33 (2.20)	11.13 (3.41)	9.70 (3.19)	2.97 (1.86)	2.63 (1.77)	2.20 (1.64)	1.30 (1.34)
T14- JS-2098	5.00 (2.35)	11.93 (3.53)	9.37 (3.14)	2.53 (1.74)	2.20 (1.64)	1.87 (1.54)	1.17 (1.29)
T15- RKS-45	3.40 (1.97)	9.47 (3.16)	9.03 (3.09)	2.10 (1.61)	3.07 (1.89)	1.20 (1.30)	1.73 (1.49)
T16- Mixture of NRC-37, JS-9752, RSC-1046 and RKS-113	3.37 (1.97)	8.43 (2.99)	6.43 (2.63)	1.30 (1.34)	1.37 (1.37)	0.93 (1.20)	0.77 (1.13)
T17- NRC-37	3.20(1.92)	9.60 (3.18)	9.03 (3.09)	2.20 (1.64)	3.50 (2.00)	2.00 (1.58)	1.57 (1.44)
T18- JS-9752	3.30 (1.95)	13.33 (3.72)	11.43 (3.45)	3.00 (1.87)	2.87 (1.83)	2.67 (1.78)	1.40 (1.38)
T19- RSC-1046	3.63 (2.03)	12.23 (3.57)	7.83 (2.89)	2.63 (1.77)	2.37 (1.69)	2.10 (1.61)	1.20 (1.30)
T20- RKS-113	4.00 (2.12)	16.57 (4.13)	9.63 (3.18)	1.80 (1.52)	2.83 (1.83)	1.77 (1.51)	1.73 (1.49)
S.Em.±	0.16	0.29	0.25	0.16	0.15	0.18	0.16
C.D. at 5%	0.32	0.58	0.50	0.32	0.30	0.36	0.33
C.V. (%)	9.24	10.36	9.96	12.05	10.17	14.86	14.67

(Figures in the parentheses are square root transformations.

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