Egyptian Journal of Plant
Protection Research Institute
www.ejppri.eg.net

Population density of certain piercing sucking insects (Hemiptera) and common predators in relation to sowing dates of soybean at Kafr El-Sheikh Governorate

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ARTICLE INFO
Article History
Received: 6 /7/2021
Accepted: 28/ 9 /2021

Keywords

Prevailing weather, piercing-sucking, aphid, predators, soybean, sowing dates and whitefly.

Abstract:

Soybean, *Glycine max* (L.) is attacked by many insect pests in the field, among them, are piercing-sucking insects, which cause damage directly by sucking plant juice or indirectly by transmission of diseases causative agent, the current work was to study the effect of two sowing dates (15thMay and 30th May) of soybean on numbers of insects and common predators at the Farm of Sakha Agric. Res. Station, Kafr El-Sheikh during of 2019 and 2020, weekly counts showed four species of insects: *Aphis gossypii* (Glov.) (Hemiptera: Aphididae); *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae); *Empoasca* spp.(Hemiptera: Cicadellidae) and *Nezara viridula* L. (Hemiptera: Pentatomidae) on soybean plants. *B. tabaci* was the most dominant insect species. The common predatory insects were *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae), *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae), *Scymnus* spp. (Coleoptera: Coccinellidae), *Orius interrupts* (Say) (Hemiptera: Anthocoridae) and *Paederus alfierii* (Koch.) (Coleoptera: Staphylinidae) in addition to true spiders. Soybean sown on 30th May harbored the highest number of the considered insects, while the least population occurred on15th May; the populations were higher in the second season than in the first one except whitefly. Plants of 15th May and 30th May harbored significantly higher population of whitefly and green stink bug in the second season, while aphid and predators induced insignificant difference between two sowing dates. Seasonal means appeared significantly differences of whitefly by first and second sowing dates, but, green stink bug harbored significantly higher differences in the first date, aphid and predators induced insignificant difference among two seasons. So, the differences in the insect population from season to another may be due to the differences in the prevailing weather factors and/or the existed natural enemies. However, the gained results are of importance in the development the control measures of insect pests in integrating management program in soybean fields.

Introduction

Soybean, *Glycine max* (L.) is one of the most important legume crops all over the world, as it shares with about 30% of the total world production of oil and more than 60% of the world production of high protein meal. Also, Soybean seeds contain about 18-24% oil, 30-50% protein and a considerable amounts of main amino acids, especially lysine as well as phosphorus, calcium and vitamins (A, B1, B2,B6, B12 , B19 and C) which are important for human and animal feeding (Abou-Attia and Youssef, 2007 and Netam *et al*., 2013). Soybean can fix a considerable amount of nitrogen of the soil and enrich soil fertility (Oerke and Dehne, 2004).

Soybean fields are attacked by a large number of arthropod pest species especially piercing-sucking insects. The most important of which are *Aphis gossypii* (Glov.) (Hemiptera: Aphididae); *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae); *Empoasca* spp.(Hemiptera: Cicadellidae) and *Nezara viridula* L. (Hemiptera: Pentatomidae) (El-Sarand, 2013 and Eissa, 2018). They cause damage in plant quality and quantity either directly by sucking plant juice or indirectly by transmission of the diseases causative agent (Iqbal *et al*., 2008).

In Egypt, farmers still greatly depend on the insecticide application to control insect pests in soybean fields. Through the widespread and sometimes indiscriminate use of pesticides, a number of serious problems have arisen destruction of beneficial arthropods and development of pest resistance to many pesticides and disruption of the ecological system. Therefore, extensive and intensive research efforts are invested to minimize the undesirable effects by using safe practices. Among these measures, are cultural practices and safe compounds against insect pests (Dent, 1991 and Mensah *et al*., 2005).

It is well known that the relation between the population sizes of the most serious insect pests and those of their associated natural enemies is an essential ecological process required for the regulation of insect population (Kogan and Herzog, 1980).

Therefore, this work was carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate during two successive soybean growing seasons, 2018 and 2019 to study effect of two sowing dates on piercing sucking insects and common predators to find out `an excellent opportunity for developing the integrated pest control programs.

Materials and methods

A field experiment was conducted at the Experimental Farm of Sakha Agricultural Research Station, (A.R.C.), Kafr El-Sheikh Governorate during two successive growing seasons of soybean, *G. max* 2019 and 2020 to evaluate the effect of two sowing dates of soybean, 15th and 30th of May on the population density of four piercing-sucking insects and common predators. For every sowing date, an area of about 1200 m^2 was divided into four plots and sown with soybean seeds Giza 111 variety. The normal cultural practices were applied without pesticide treatments throughout the whole growing season.

To determine the populations of aphids (Nymphs and adults), leafhoppers (Nymphs and adults) and whitefly (Adults), a weekly sample of 20 leaflets representing upper, middle and lower levels of plants was selected at random from each plot for every sowing date. The number of the considered insects was directly counted in the early morning. In the field using a suitable hand lens. The same leaflets were picked up and transferred into paper bags to the laboratory for examining and counting of the nymphal

stages of the whitefly by a binocular microscope.

As for the green stink bug and the common associated predators, a weekly sample of 10 plants was randomly selected from each plot. The numbers of the considered insects were counted directly and recorded in the field by the aid of lens 8 xs. The existed predators were *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) (Larvae), *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae) (Larvae and adults), *Scymnus* spp. (Coleoptera: Coccinellidae) (Nymphs and adults), *Orius interrupts* (Say) (Hemiptera: Anthocoridae) (Adults) and *Paederus alfierii* (Koch.) (Coleoptera: Staphylinidae) (Adults) and true spiders. The inspection began four weeks after sowing and continued till the end of the season.

The data of the means of the considered insects and the predators were statistically analyzed using t-test to compare the differences between them.

Results and discussion

1. Effect of soybean sowing dates on the population density of certain piercing-sucking insects and the common associated predators:

Data presented in Table (1) clear effect on two sowing dates of soybean (15th and 30th May) on the population density of piercing-sucking insects and the common predators in season of 2019. It was observed four insect species: aphids, *Aphis* spp.; whitefly, *B. tabaci* ; leafhoppers, *Empoasca* spp. and green stink bug, *N. viridula* on the plants sown in the two dates. Also, five predatory insects were found: *C.carnea*, *C. undecimpunctata* , *Scymnus* spp. *O. interrupts* and *P. alfierii* in addition to true spiders. Because of very low numbers of predators it was taken in consideration as total.

With regard to aphid *A.gossypii* the population started to appear on plants of 15th May in low numbers on the 30th Jun. with a mean of 3.00 insects /20 leaflets, then population increased gradually recording a peak of 21.50 insects/20leafles on 10th Sept. In the second sowing date, aphids appeared on 21st Jun. with a mean of 5.00 insects /20 leaflets, then, fluctuated recording a peak of 23.75 insects/20 leaflets on 3rd Sept.

As for the whitefly, *B.tabaci* , the population began to appear in low number by 14th and 30th Jun. on plants of the first and second sowing dates, then, the population increased gradually forming two peaks of abundance for the first and second sowing dates by Jul. 28th and August 5th, respectively. The first peak was represented by 183.25 and 200.00 insects / 20 leaflets for the first and second sowing dates, respectively, while the second peak recorded 459.25 and 460.25 insects by 21st Sept. and 10th Sept., respectively. After that, gradually decreased in the population occurred till the end of the season.

Regarding the leafhoppers, the results cleared that the insects appeared in relatively low numbers on June 14th (3.25 insects/20 leaflets) for the first sowing date and on June 21st by a mean of 3.25 insects /20 leaflets for the second sowing date. Then, population fluctuated during the season, recording high numbers on 26th and 12th August on plants of the first and second date with means of 20.50 and 22.50 insects/20 leaflets, respectively. After that, the population gradually decreased till the end of the growing season.

Table (1):population density of *Aphis gossypii* , *Bemisia tabaci, Empoasca* spp., *Nezara viridul*a and predators on soybean plants sown in two dates in season of 2019 at Kafr El-Sheikh Governorate.

I.D.	Mean number/20 leaflets						Mean number/10 plants			
	Aphis gossypii		*Bemisia tabaci*		*Empoasca* spp.		*Nezara viridul*a		Predators	
	15th May	30th May	15th May	30th May	15th May	30th May	15th May	30th May	15th May	30th May
Jun. 14	0.00	0.00	7.00	33.25	3.25	0.00	0.25	0.00	4.00	7.50
Jun. 21	0.00	5.00	10.00	37.25	3.50	3.25	1.00	3.60	7.50	8.00
Jun. 30	3.00	5.75	20.25	64.25	5.50	4.00	1.50	2.00	11.00	6.75
Jul.7	5.25	8.50	33.25	108.00	6.50	5.75	3.25	2.50	10.00	8.25
Jul. 15	6.50	12.75	64.25	150.25	11.50	9.75	4.50	10.50	10.50	10.25
Jul. 21	7.50	11.00	93.50	160.25	10.00	11.50	5.75	10.00	11.00	9.25
Jul. 28	8.75	13.50	183.25	167.50	10.75	13.75	6.25	10.50	12.00	11.25
Aug. 5	10.75	14.25	165.00	200.00	10.50	15.00	7.25	11.50	12.00	11.50
Aug. 12	12.00	19.50	129.25	185.50	14.25	22.50	8.75	12.00	10.00	9.00
Aug. 19	15.00	20.00	150.25	200.75	15.00	17.00	3.25	13.00	12.75	12.00
Aug. 26	18.50	22.50	160.25	223.50	20.50	15.00	8.50	15.25	9.00	13.25
Sept. 3	19.50	23.75	185.50	294.45	15.00	7.75	9.50	16.50	9.50	12.00
Sept. 10	21.50	17.75	200.75	460.25	12.00	8.00	6.50	15.00	9.25	11.00
Sept. 17	11.50	13.00	294.50	321.50	4.75	6.75	12.50	6.00	9.00	9.75
Sept. 21	11.25	7.00	459.25	160.00	8.00	3.00	15.00	3.00	6.25	5.75
Sept. 28	8.00	5.00	322.50	150.50	6.75	2.75	5.00	3.50	4.00	4.50
Seas-onal mean ±SE*	9.94± 0.49	12.45± 0.19	154.92 ±2.18	182.33 ±2.77	9.86± 0.16	9.11± 0.08	6.17± 0.33	8.43± 0.20	9.23± 0.19	9.38± 0.20

SE*=Stander error I.D. Inspection date

Concerning of the green stink bug, *N. viridula*, the population firstly appeared on 14th and 30th Jun. for the first and second sowing dates, respectively. After that, the Population increased gradually recording two peaks on Aug.12th and Sept.17th by means of 8.75 and 15.00 insects/10 plants, respectively in first sowing dates, while one peak was formed on Sept. 3rd on plants of the second date by mean 16.50 insects/10 plants**.**

As for the common predators in soybean based on the total number of the existed predators it was observed that the population started to appear by 14th Jun. on the plants of two dates. After that, the population suddenly increased forming one peak for first sowing date and the second one by1 9th and 26th August in first and second sowing dates with means by 12.75 and 13.25 individuals/10 plants, respectively . *C. carnea* was the most dominant predator forming percent 28.79% and 30.58 of the total predators, while *O. interrupts* was least one by 6.12% and 5.33 of the total predators in

first and second sowing dates ,respectively .

Data presented in Table (2) show the population density of piercing-sucking and the common predators on the two sowing dates of soybean in season of 2020. It was observed four insect species and five predatory insects, in addition to true spiders. The same species were observed similar to the first season.

As for aphid, *A. gossypii* , appeared on soybean plants of the first date in relatively low numbers on 21st June by a mean of 1.00 insects /20 leaflets .After that, the population increased gradually to reach high levels recording peak on 16th of September with a mean of 37.00 insects/20 leaflets, while for the second sowing date aphids appeared on 21st Jun. (5.50 insects /20 leaflets), then fluctuated recording one peak (35.00 insects/20 leaflets) on 9th of September and continued decreased till the end of season.

With regard to the whitefly, *B.tabaci* , the population began to appear in moderate number by 14th Jun. on plants of the first and second sowing dates, then, the population gradually increased to record two peaks of abundance for every sowing date. The first peak took place by July 22nd for the first and second sowing dates by means of 110.50 and 234.00 insects/20 leaflets, respectively. The second peak occurred on plants on 19th and 26th Aug.in the first and second dates by means of 67.00 and 110.00 insects, respectively.

The results revealed that the plants of the two dates in season of 2019 as well as those of the second date in the season of 2020 harbored the highest number of populations with means of 154.92, 182.33 and 100.09 insects, respectively. The plants of the first dates in the season of 2019 received the lowest number by means of 50.85 insects. Also, the population density of the insect was relatively higher during the first season than the second one.

As for, leafhoppers, *Empoasca* spp., the population appeared in relatively low numbers on June 14th by a mean of 3.00 insects/20 leaflets for the first sowing date and on June 21st by a mean of 3.25 insects / 20 leaflets for the second sowing date, then the population recorded the highest number of abundance on 9th and 23rd Sept. on the plants of the first and, second date with means of 19.50 and 21.25 insects/20 leaflets, respectively after that, the population declined gradually till the end of season. According to the seasonal mean throughout the study period, results revealed that plants of the second date harbored the highest number (13.91 insects / 20 leaflets) for the second seasons. On the other hand, the lowest number of the population (9.11 insects / 20 leaflets) took place on plants of second date for first seasons. Also, the population density of leafhoppers was higher in the second season than in the first one.Concerning of the green stink bug, *N. viridula* , started to appear on soybean plants of the two sowing dates on 14th June. The population of *N. viridula* increased gradually forming the highest number recorded two peaks on 22nd Jul. and 12th Aug. with means of 16.50 and 19.00 insects/10 plants, respectively in first sowing date ,while in second one was formed one peak on Aug.19th by means 15.50 insects/10 plants. After that, the population decreased till the end of the season. The population density of the insect was relatively higher in the second season than in the first one. The results revealed that the second sown plants in the first season were more preferable to infestation by *N. viridula* and first sowing plants in the second season.

As for, the common predators with piercing sucking insects, data cleared that the common predatory

complex fluctuated during the inspection period and the population started in moderate numbers by June 14th on plants of the first and second sowing dates, then, the population increased gradually forming one peak in first sowing date and in the second one by means of 19.00 and 16.25 individuals/10 plants by 12th and 26th August in first and second sowing dates. *C. carnea* was the most dominant predator forming 29.11 and 41.63% of the total predators, while *O. interrupts* was least one by 7.12 and 2.02% of the total predators in first and second sowing date, respectively.

Table (2): Population density of *Aphis gossypii, Bemisia tabaci, Empoasca* spp. , *Nezara viridula* and predators on soybean fields during season of 2020.

I.D.	Mean number/20leaflets						Mean number/10 plants			
	Aphis gossypii		*Bemisi tabaci*		*Empoasca* spp.		*Nezara viridula*		Predators	
	15th May	30th May	15th May	30th May	15th May	30th May	15th May	30th May	15th May	30th May
Jun. 14	0.00	0.00	20.00	25.00	3.00	3.25	2.75	0.50	2.75	4.25
Jun. 21	1.00	0.00	30.00	45.25	3.75	4.25	6.25	1.00	6.25	7.00
Jun. 28	1.75	0.00	63.00	143.25	5.00	6.25	9.50	1.00	9.50	7.75
Jul.8	2.00	5.50	96.00	148.00	7.50	8.50	12.50	1.50	12.50	8.50
Jul. 15	3.00	8.75	100.00	158.25	12.75	15.75	13.25	2.50	13.25	10.00
Jul. 22	7.00	12.00	110.50	234.00	15.75	16.75	16.50	4.00	16.50	12.50
Jul. 29	8.00	15.50	59.50	54.00	14.00	16.00	11.50	7.00	11.50	12.75
Aug. 5	10.00	18.75	60.00	88.50	13.00	17.00	11.00	15.50	11.00	10.75
Aug. 12	10.50	20.00	65.00	90.00	13.00	15.00	19.00	12.00	19.00	14.50
Aug. 19	11.25	22.75	67.00	100.25	15.00	18.00	11.25	11.00	11.25	16.00
Aug. 26	13.00	25.00	60.00	110.00	16.00	16.00	12.50	5.00	12.50	16.25
Sep. 2	13.50	27.25	30.00	105.75	17.25	17.25	14.00	8.00	11.50	10.75
Sep. 9	22.75	35.00	20.75	100.00	19.50	19.50	13.75	5.00	13.75	8.75
Sep. 6	37.00	31.25	17.00	87.00	14.50	20.50	11.25	8.00	11.25	4.50
Sep. 23	32.00	29.00	12.00	71.67	10.00	21.25	10.25	9.00	10.25	10.75
Sep. 30	30.00	30.00	3.00	40.50	5.25	7.25	5.00	6.25	5.00	11.00
Seas-onal mean ±SE*	12.67± 0.23	17.55± 0.72	50.85± 1.02	100.09± 2.20	11.58± 0.44	13.91± 0.39	11.27± 0.65	6.08±0 .12	11.11± 0.82	10.38± 0.98

SE*=Stander error I.D. Inspection dates

From the previous results, it can be concluded that, during the first season, the maximum density of aphids and whitefly was nearly observed during the period from mid-July to end of September synchronizing with the

occurrence of higher population of the predators, while the leafhoppers and green stink bug attained its maximum density during the period from mid-August to end of September. Regarding the second season, the considered insects recorded maximum densities during the period from late July to mid-September synchronizing with the higher density of the associated predators. However, the interaction between the insects and their natural enemies is an essential ecological process that contributes the regulation of insect population (Dent, 1991). In general, results indicated that, sowing date of soybean had a significant effect on the population density of aphids, as the second sowing date (30th May) exhibited the highest densities of aphids, where the lowest densities of aphids took place on the first sowing date (15th May). Also, the population density of aphids was higher during the second season than the first one for the two sowing dates.

However, the aphid population greatly differed according to the sowing dates, 15th and 30th May. Results were in agreement with those of Karungi *et al*. (1999) who found that the early planting of soybean reduced aphid infestation. On contrast, Mousa (2004) revealed that soybean plants sown early on April 24th harbored the highest infestation levels of *Aphis* spp. as compared with those on May 11th. The results were agreeing with those of Abd El-Aty (2011), who studied the effect of two sowing dates; 15thMay and15th June on the infestation of soybean with *A. gossypii*. The total number of *A. gossypii* during the two sowing dates in the first season indicated that the difference was insignificant, while in the second season, the number of aphids was insignificantly higher in the first sowing date than in the second one Also, El-Sarand (2013) found that soybean sown in early May harbored the lowest numbers of *A. gossypii* population. Also, Results were agreement with those of Eissa (2018) she revealed that plants in mid -and late May received the highest number of aphids. These results are in agreement with those of Rizk *et al*. (1990b) who showed that infestation of soybean plants with *B. tabaci* increased with the later planting date (1stJun.). Results agreeing with those of El-Sarand (2013), who found that soybean plants sown on the 1st of June harbored higher densities of *B. tabaci*, while the first sowing date (1st May) had the lowest numbers of insects during 2009 and 2010 seasons.

Also, the second sowing date exhibited moderate numbers. Kalyan and Ameta (2017) found that the mean population of whitefly in the first week of July was significantly higher than the third week of July during two seasons in India. Eissa (2018) revealed that the plants of the third date (30th May) harbored the highest numbers of *B. tabaci* during the first and second season, respectively. On the other hand, the lowest mean numbers took place on the plants of the first date (5th May) in both seasons.

In another hand, these results were contrasted with Rizk *et al*. (1990a) they found that soybean planted earliest (1st Apr.), had the highest infestation of *Empoasca decipiens* Paoli. Similar trend was reached by El-Sarand (2013), who found that soybean sown in early May harbored the lowest numbers of leafhoppers, while plants sown in late May received higher population. Also, Eissa (2018) revealed that plants were sown on 30th May harbored the highest number of leafhoppers for the first and second season and on contrast the plants sown 5thMay.

On contrary, Rizk *et al*. (1990b) found that the soybean plants sown earliest (1st Apr.) had the largest infestation of *N. viridula* . These results

disagree with those of Adamu *et al*. (1999) who found that the sowing date of soybean did not significantly affect the infestation with *N. viridula* . Also, Gore *et al.* (2006) found that the earliest planting date (Late March-early April) had the lowest densities of stink bugs, whereas the latest planting date (Late May-early June) had the highest densities of stink bugs. The results agree with those of Gore *et al*., (2006), who found that the earliest planting date(15th Apr.) of soybean had the lowest densities of stink bugs, whereas the late planting(5th Jun.) attract and harbored the highest densities of stink bugs. Also, Omoloye *et al*. (2015) found that *N. viridula* population was significantly higher at late planting date (25th Jul.) of soybean. Eissa (2018) found that the early sown plants (5th May) in the first season were more preferable to infestation by *N.viridula* and late sowing date (30th May) in second season.

With regarded to, these results agree with obtaining data by Samhan (2003) who found *C. undecimpunctata*; *C. carnea*; the *P. alfierii* and unidentified species of true spiders in soybean fields during 2000, 2001 and 2002 growing seasons. El-Sarand (2005) in Egypt, found three predator species; *P. alfierii, C. undecimpunctata* and *C. carnea* in soybean fields during 1999 and 2000 seasons. *C. carnea* was the most dominant during the two study seasons, El-Sarand (2013) he recorded predator in soybean field; *C. carnea, C. undecimpunctata, P. alfierii* and *Scymnus* spp. during 2009 and 2010 seasons. Also, *C. carnea* was the most dominant species. Yadav *et al*. (2015) found that the predatory beetles began to appear on soybean field during 2010 season in the 2nd week of August and its population slightly increased and peaked at 63 days after sowing. The maximum population of predatory observed in 2nd week of July. Also, the spiders appeared at 35 days after sowing, in the second week of August and its population slightly increased up to 49 days after sowing, thereafter a gradual reduction in the population was observed and finally disappeared after 77 days after sow.

However, varying the planting date of crops works as a mean of cultural control by creating asynchrony between crop phenology and the insect pests' phenology which can retard the rate of colonization (Ferro, 1987) or means that the pest fails to coincide with a critical crop growth stage (Dent,1991). Also, such methods have a major impact if the planting dates were synchronized between farms within a region to reduce the variation in available crop stages. 2-Seasonal means of four piercing-sucking insects and common predators on soybean plants at two sowing dates during 2019 and 2020 seasons at Kafr El-Sheikh Governorate. Results analysis in Table (3) cleared that the plants of 15th May and 30th May harbored significantly higher population of whitefly and green stink bug in second season than first one, while aphid and predators induced insignificant difference between the two sowing date also, leafhoppers harbored significantly population in second sowing dates of second season, while the mean numbers of green stink bug was significantly higher between first sowing dates in booth seasons.

From the mentioned results ,during two seasons that the first and second sowing dates; whitefly recorded significantly differences, while leafhoppers appeared significant differences in the second swing date, but, green stink bug harbored significantly higher differences in first sowing date ,while aphid appeared insignificant.

In general, the results indicated that soybean plants sown in 15th May received lower population of the

considered insects. Similarly, the population of insects was higher in the second season than in the first one except whitefly. However, the differences in the insect population from season to another may be due to the differences in the prevailing weather factors and/or the existed natural enemies. Results will aid in planning programs of integrated control of soybean insect pests.

Table (3): Seasonal means of four piercing-sucking insects and common predators on soybean plants at two sowing dates during 2019 and 2020 seasons at Kafr El-Sheikh Governorate.

Insect	Season	Sowing date		
		15th May	30th May	T-calculated
Aphis gossypii	2019	9.94	12.45	1.06$^{n.s}$
	2020	12.67	17.55	1.65$^{n.s}$
	T- calculated	0.82$^{n.s}$	1.47$^{n.s}$	
Bemisia tabaci	2019	154.92	182.33	0.66$^{n.s}$
	2020	50.85	100.09	3.18**
	T- calculated	3.03*	2.72*	
Empoasca spp.	2019	9.86	9.11	0.38$^{n.s}$
	2020	11.58	13.91	1.18$^{n.s}$
	T- calculated	0.97$^{n.s}$	2.23*	
Nezara viridula	2019	6.17	8.43	1.33$^{n.s}$
	2020	11.27	6.08	3.47**
	T- calculated	3.54**	1.35$^{n.s}$	
Predators	2019	9.23	9.38	0.16$^{n.s}$
	2020	11.11	10.38	0.55$^{n.s}$
	T- calculated	1.57$^{n.s}$	0.92$^{n.s}$	

T-tabulated =1.697at 5% level, = 3 .042 at 1% level

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