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Monitoring of quantitative and qualitative losses by lepidopteran, and homopteran pests in different crop production systems of *Brassica oleracea* L.

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Abstract
The present study was conducted in 2014-2015 to assess seasonal qualitative and quantitative losses by insect pests in different crop production systems of *Brassica oleracea*. The experiment was conducted on Entomological Research Area Young Wala, Department of Entomology, University of Agriculture Faisalabad the experiment was comprised of five treatments each had comprised of 68 plants grown in four rows. Plant to plant and row to row distance was maintained as 0.84 ft^2 and 24 ft^2 respectively. First season experimentation results showed the highest yield of *Brassica oleracea* in grower standard (2.24%) cultivation method second season experimentation showed maximum yield (1.92%) in reducing risk pesticides cultivation method. On basis of results present study suggests reduced risk pesticides and grower standard cultivation methods are better than other treatments because less qualitative and quantitative losses were observed in these treatments.

Keywords: Black Mulch**,** *Brassica oleracea, B. oleracea*, crop system, monitoring, integrated pest management

1. Introduction

Being an agricultural country, Pakistan produces almost all vegetables including *Brassica oleracea*. Pakistan has produced 0.071731 million tons of *B. oleracea*, including other crucifers on 0.004345 million hectares [1, 2]. Lepidopteran and homopteran are mainly producing problems in production and results in a reduction of yield, for their control different insecticides are used [3, 4]. Use of broad-spectrum insecticides also affects the population of natural enemies and biological control agents [5-9]. In *B. oleracea* natural enemies' population and performance are increased by organic farming [10-12].

Mulches play an important role to avoid qualitative and quantitative losses [13]. Black mulch is providing good control for many years by preventing weeds from establishing in crops due to the covering of soil which blocks light for weed seeds [14]. It is also valuable for warming soil during the growing seasons. The scope of production systems which use in *B. oleracea* are described that promote the quality, safety of *B. oleracea*, improve productivity and profitability of *B. oleracea*, Controlling the cost of production and Improved field drainage [15]. These production systems improved marketing and packaging, increasing consumer trend for buying local, knowledge on the part of retail marketers of how to handle *B. oleracea*, Market demand is there a trend for increased or decreased *B. oleracea* consumption and improved storage post-harvest handling techniques and enhance research efforts through collaborative pilot projects and initiatives [16]. Processing operations such as spillage, abrasion, excessive polishing, peeling and trimming can also add to the loss of commodity [17]. Physiological deterioration of vegetables refers to the aging of products during storage due to natural reactions [18]. Considering the importance of *B. oleracea* crops, the present study was aimed to Assess quantitative and qualitative losses in *B. oleracea* due to insect pests and the effective *B. oleracea* production systems which are mostly used in Pakistan by farmers so that good cultivation method can be suggested.

2. Materials and Methods

2.1. Experiment Layout and Treatment Applications

The experiment was conducted on Entomological Research area Youngwala, Department of Entomology, University of Agriculture Faisalabad (2014-2015). In this experiment, the plant-to-plant and row-to-row distance were kept at 10 and 25 inches, respectively. The experiment was comprised of five treatments given below in (Table 1), each had comprised of 68 plants grown in four rows. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The size of each subplot was 10x15 ft^2. Upon the appearance of the pest, data was recorded from the 5 randomly selected plants from each treatment. Numbers of insect pests were counted from five plants selected from each treatment. The observations were repeated at weekly intervals till harvest of the crop [15].

Table 1: Treatments used during the present experiment.

T. No.	Treatments Name (crop production systems)	Details
T1	Integrated Pest Management (IPM)	Yellow sticky trap, Eradication of weeds by hoeing, Thiacloprid 1.5ml/1.5L Chlorpyrifos 2.5ml/1.5L
T2	Reduce risk pesticide (RRP)	Emamectin 2.5ml/1.5L Pyriproxyfin 2.5ml/1.5L
T3	Black mulch (BM)	Black Mulch
T4	Grower standard	Lambda cyhalothrin 1.25ml/1.5L Imidacloprid 0.75ml/1.5L
T5	Control	Application of water only, no insecticide and no mechanical control

2.2 Installation of different Production Systems

In IPM plot, all control measures such as mechanical, cultural and chemical control were applied. In case of mechanical control, different traps like yellow sticky trap were used to control the insect pests [19]. In case of chemical control, thiacloprid and chlorpyrifos were used. But in case of cultural control weeds were removed through hoeing and other cultural practices to improve crop growth. In reduced risk pesticide treatment, insecticide was applied as control measures. For this purpose, emamectin and pyriproxyfen were applied in the field. In grower standard, imidacloprid and lambda-cyhalothrin were applied. Lambda-cyhalothrin was applied in grower standard because it is a pyrethroid insecticide and widely used to control different pests in various crop ecosystems. In third treatment, black mulch was used and other control practices if required [20]. The means were analyzed by analytical software (Statistics version 8.1) and compared to LSD test at 0.05 probability levels

2.3 Qualitative Data

In qualitative data, head height, head width, was measured according to International System of the unit.

2.4 Quantitative Data

In quantitative data, yield, and percent leaf damaged was observed. The percentage leaf damage was calculated by using the following formula.

$$\text{Percent damaged leaf} = \frac{\text{No. leaves having eating symptoms}}{\text{Total leaves of the plant}} \times 100$$

3.0 Results

3.1 The yield of *B. oleracea* in different treatments in the first season.

Maximum yield of *B. oleracea* was observed in grower standard (2.24%) that was 0.05 times more than other treatments and after that, it was observed in reducing risk pesticides (2.096%), and control (2.09%) and black mulch (2.01%). But the minimum yield was observed in IPM treatment (1.44%) (df=8, f=73.1 and p<00**) as in Fig.1.

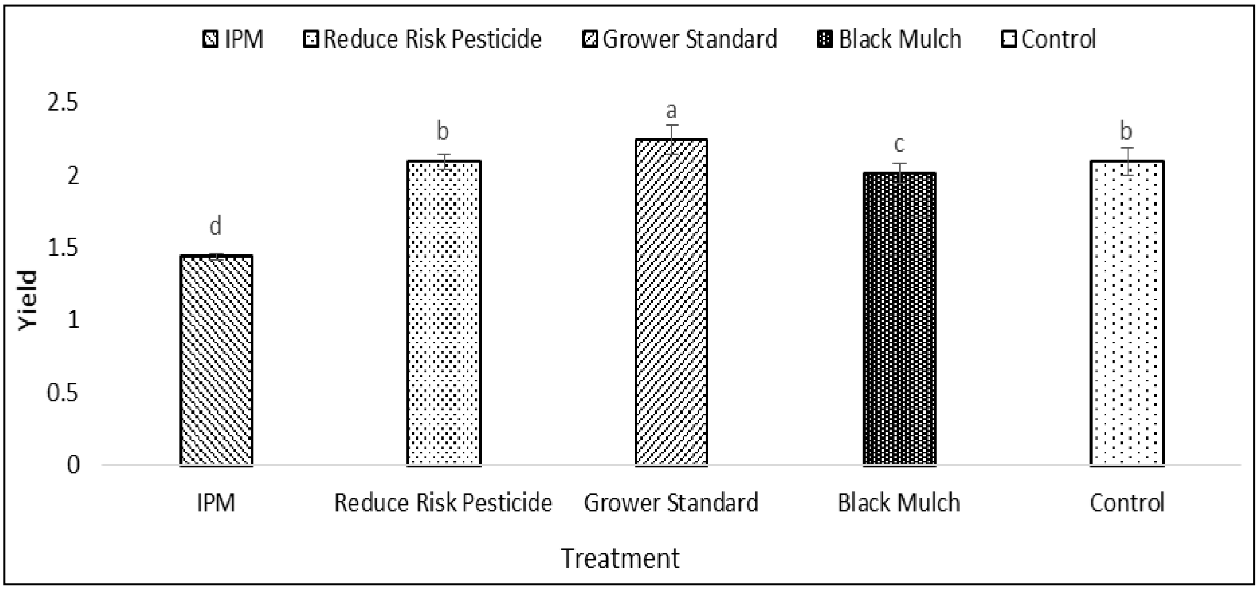

Fig 1: The yield of *B. oleracea* in different treatments in the first season.

3.2 The yield of *B. oleracea* in the different treatments second season.

High yield (1.92%) was observed in reduce risk pesticides and minimum yield was observed in control treatment (1.24%) (df=8, f=1.65, and p<00**)as in fig 2.

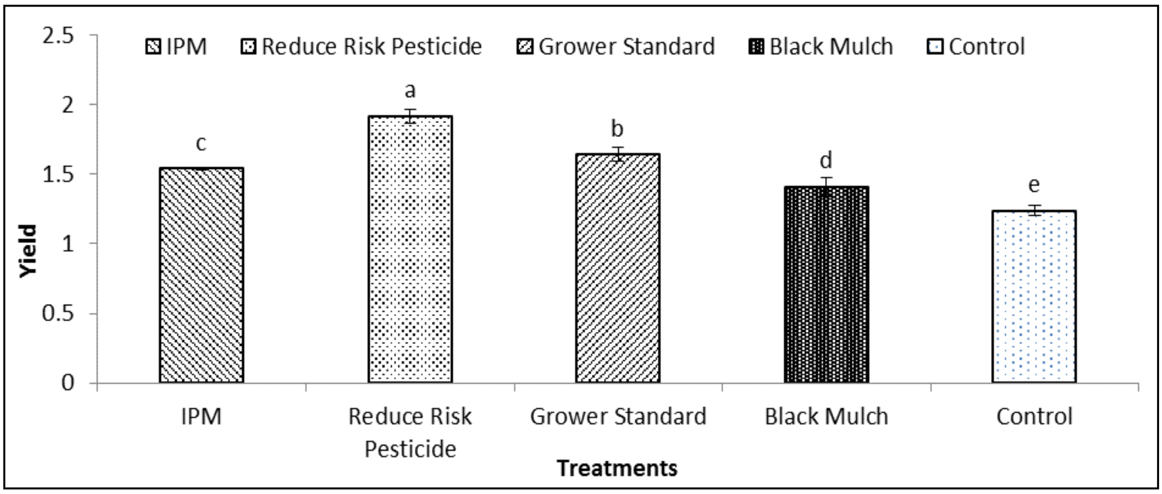

Fig 2: Yield of *B. oleracea* in the different treatments second season.

3.3 Percentage leaf damage of *B. oleracea* in different treatments before and after the first spray.

The lowest leaf damage percentage was observed in reduced risk pesticides (19.33%) and the maximum was observed in control (48.13%) (*df*=8, f=84.2 and $p<00^{**}$) before 1^{st} spray. The minimum leaf damage percentage was observed in reduced risk pesticides (3.66%) after the first Spray and this percentage was maximum in the control treatment (41.86%) (*df*=8, *f*=2.02 and $p<00^{**}$) as shown in fig 3.

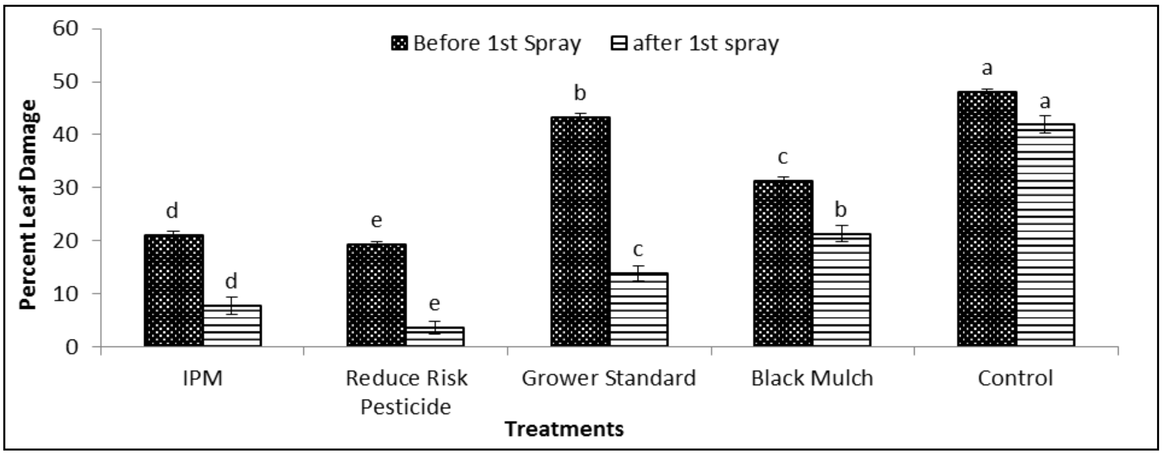

Fig 3: Percentage leaf damage of *B. oleracea* in different treatments before and after the first spray

3.4 Percent leaf damage of *B. oleracea* in different treatments before and after the second spray

Minimum leaf damage percentage was observed in RRP (46.80%) treatment before the second spray and this percentage was maximum in the control treatment (73.03%) (*df*=8, *f*=2.03 and $p<00^{**}$).Minimum leaf damage percentage was observed in RRP (2.33%) and maximum in control Treatment (56.96%) (*df*=8, f=1.68, and $p<00^{**}$) after the second spray as shown in fig 4.

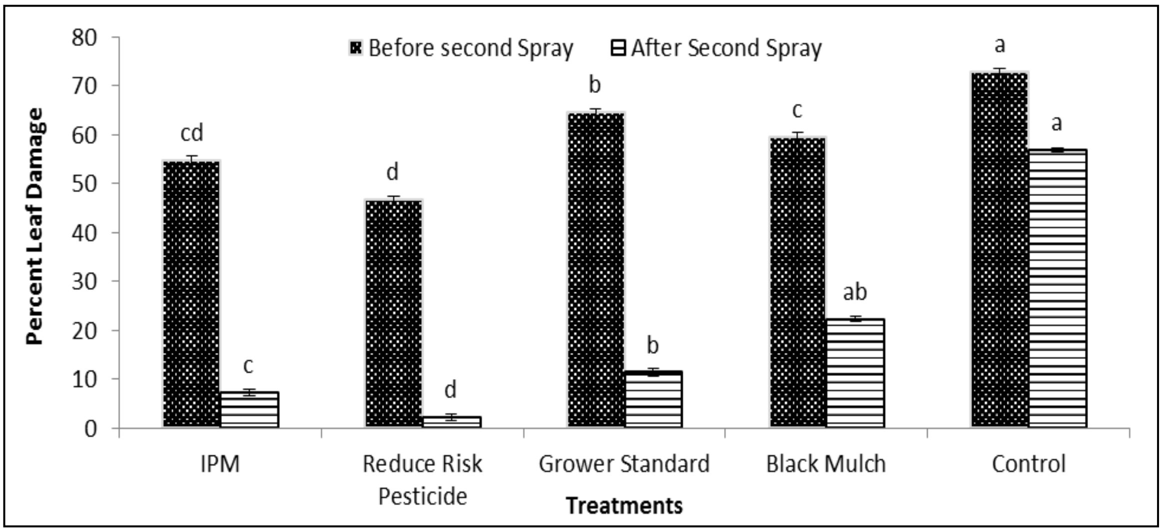

Fig 4: Percent leaf damage of *B. oleracea* in different treatments before and after the second spray

3.5 Percent leaf damage of *B. oleracea* in different treatments before and after the third spray

The minimum leaf damage percentage was observed in RRP (29.43%) treatment and was Maximum in control treatment (57.20%) (*df*=8, *f*=5.69, and *p*<00**) before the third spray. Minimum leaf damage percentage was observed in RRP (2.01%) and was maximum in control Treatment (9.10%) after the third spray as shown in fig 5 (*df*=8, f=5.69, and *p*<00**).

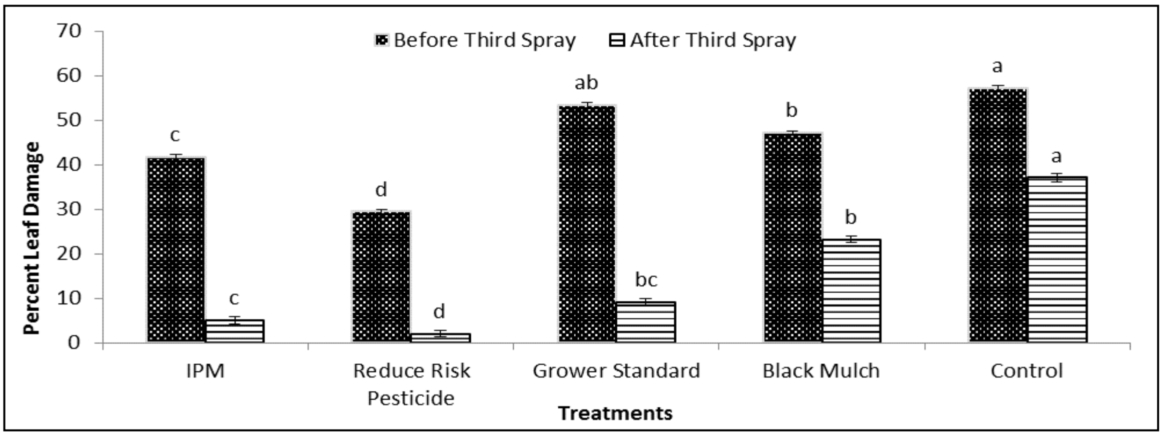

Fig 5: Percent leaf damage of *B. oleracea* in different treatments before and after the third spray

3.6 Plant height of *B. oleracea* in different treatments after first, second, third, fourth, fifth and the sixth week of first season crop.

The maximum height was observed in Reduce risk pesticides after 1st 2nd 3rd 4th 5th and 6th weeks (20.37%), (22.33%), (25.10%), (25.10%), (25.10%), (25.10%) respectively. Minimum height was observed in control treatment (17.85%), (20.55%), (20.01%), (21.16%), (22.15%), (24.96%) after 1st 2nd 3rd 4th 5th and 6th weeks respectively as shown in fig 6.

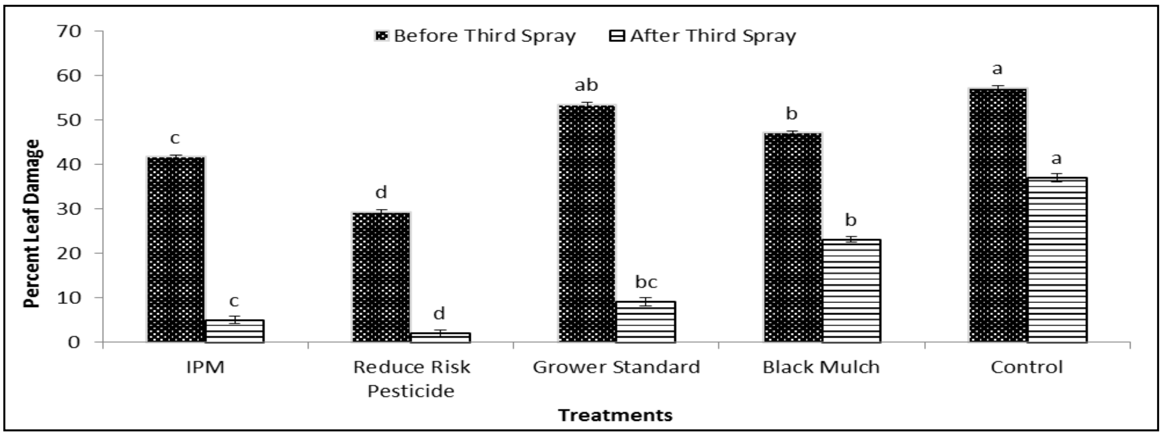

Fig 6. Plant height of *B. oleracea* in different treatments after first, second, third, fourth, fifth and sixth week in first season crop.

3.7 Plant height of *B. oleracea* in different treatments of second season crop after 1st, 2nd, 3rd4th, 5th and 6th week.

The maximum height was observed in IPM after 1st, 2nd, 3rd, 4th, 5th and 6th weeks as (18.90%), (19.90%), (20.41%), (21.79%), (22.53%), (23.40%) respectively. While minimum height was Observed in black mulch treatment (14.60%), (15.43%), (16.34%), (17.80%), (18.30%), (19.40%) after 1st, 2nd, 3rd, 4th, 5th and 6th weeks respectively shown in fig7.

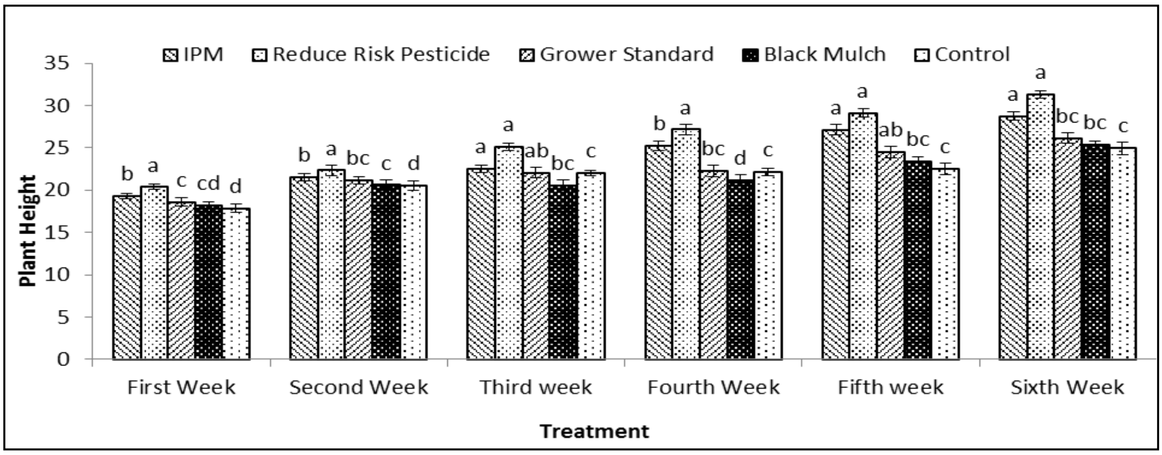

Fig 7: Plant height of *B. oleracea* in different treatments of second season crop after 1st, 2nd,3rd, 4th, 5th and 6th week.

3.8 Plant width of *B. oleracea* in different treatments of first season crop after 1st, 2nd, 3rd, 4th, 5th and 6th week

Maximum plant width was seen in IPM (20.75%), (21.00%), (22.36%), (23.49%), (24.58%), (25.78%) and minimum width was observed in control treatment (16.18%), (17.53%), (18.07%), (19.19%), (20.71%), (21.78%) after 1st, 2nd, 3rd, 4th, 5th and a 6th week respectively as Shown in fig 8.

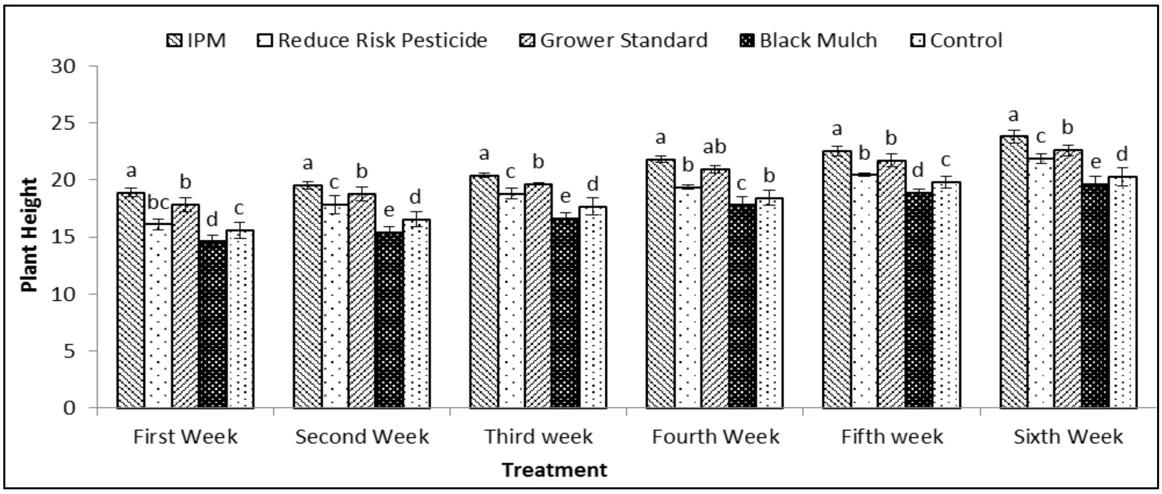

Fig 8: Plant width of *B. oleracea* in different treatments of first season crop after 1st, 2nd, 3rd, 4th, 5th and 6th week.

3.9 Plant width of *B. oleracea* in different treatments of second season after1st, 2nd, 3rd, 4th, 5th and 6th week.

The maximum plant width was observed in grower standard (17.00%), (18.26%), (19.60%), (20.92%), (21.58%), (22.91%) and minimum width was observed in black mulch treatment (14.50%), (14.76%), (15.16%), (15.43%), (16.31%), (17.43%) after 1st, 2nd, 3rd, 4th, 5th and 6th Week respectively as shown in fig 9.

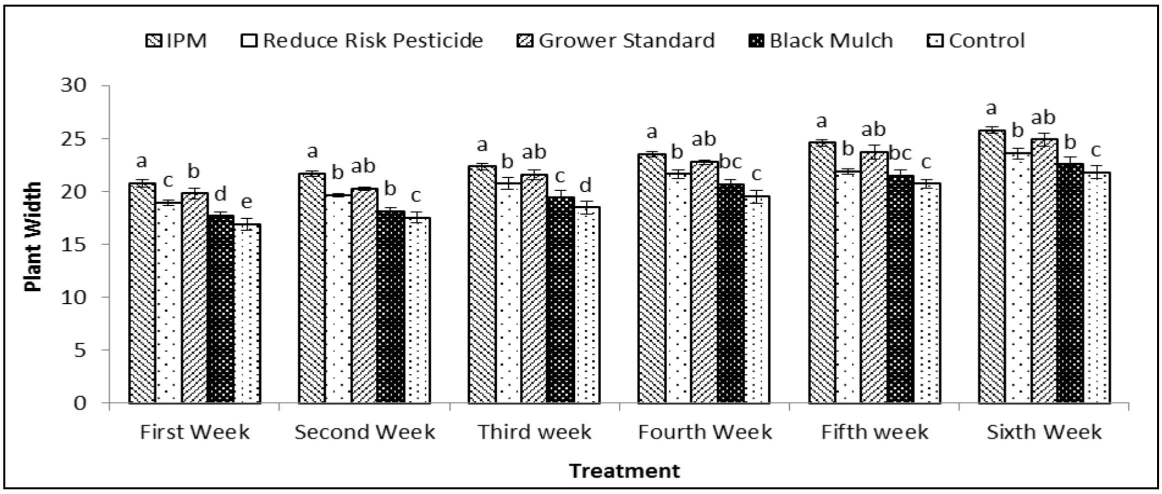

Fig 9: Plant width of *B. oleracea* in different treatments of second season crop after 1st, 2nd, 3rd, 4th, 5th and 6th week.

4. Discussion

Five treatments viz., integrated pest management, reduced risk pesticides, grower standard, black mulch, and control were used to check the quantitative and qualitative losses cause by different insect pest and their damage pattern. The trial was laid out in Randomized Complete Block Design (RCBD) with three replications at the experimental area of Entomological Research Institute, Faisalabad. The data regarding these treatments was recorded by selecting five plants randomly from each plot. In present findings, all treatments show significant differences and the treatment reduce risk pesticide proved to be best in the majority of parameters than other parameter but the quality of this treatment like head width and head height were affected due to high temperature in second season *B. oleracea*. These findings are in conformity with those of [21] studied the influence of temperature on white *B. oleracea* in the East Mediterranean region of Turkey. The increasing temperatures resulted in shorter the growth of *B. oleracea* and its width and height due to this its quality were decreased. But first season *B. oleracea* was not affected because at this stage the temperature was optimum and had not affected the quantity and quality of *B. oleracea* crop. Due to excessive use of insecticide the insect pest was resistance against different control practices due to this problem was occurred to control different insects and they had caused very serious damage both qualitative and quantitative [22] revealed that indiscriminate use of pesticides has resulted in the development of resistance and resurgence in the pest besides environmental and health hazards. The high intensity of insecticide sprays causes mortality of beneficial arthropods associated with predation or parasitism [23] investigated that parasitoids and predators of the *B. oleracea* aphids, five different sites of North West Frontier Province (NWFP) of Pakistan. The present findings show that reduce risk pesticides and grower standard is better than other treatments because less qualitative and quantitative losses were observed in it than other treatment and it is same as [24, 25]. From all these treatments the control treatment had more quantitative and qualitative losses due to improper management and environmental hazards [26]. Studied the annual generations of *B. brassicae* (L.) on *B. oleracea* in insectary and reported that species had four nymphal instars and were always viviparous and parthenogenetic. Cool, wet weather favored its development, shortening all stages except for the period between reproduction and death and resulting in high fecundity and low mortality in winter and had 39 generations a year under insectary conditions. [27, 28, 21] studied that vegetables are diverse in their morphological structure, nutritional composition, and general physiology. Therefore, the requirements and recommendations for maximum postharvest life vary among the different groups of vegetable commodities. Both qualitative and quantitative losses had caused by improper application of crop production systems either late planting, late harvesting, excessive application of insecticides and environmental hazards. While keeping the problem of quantitative and qualitative losses in view, present investigation will be a milestone in this regard and further research work is needed here.

5. Conclusion
In conclusion growers should not use the broad-spectrum pesticides only target specific pesticides should be used as used in reduce risk pesticide cultivation method in current experimentation that's why After seeing results it is suggested that in Pakistan reduce risk pesticides and grower standard cultivation methods are providing promising control of insect pest and enhance the yield of *Brassica oleracea*.

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