JOURNAL OF AGRICULTURE AND BASIC SCIENCES
ISSN Online: 2518-4210
http://www.jabsjournal.com/

Full Length Research Article

Assessment of quantitative and qualitative losses by insect pests in different crop production systems of cabbage (*Brassica Oleracea* L.)

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Abstract

Cabbage (*Brassica oleracea* L.) is the most common Cole crop that thrives best in cool season. Many insect pests attack on cabbage and cause quantitative and qualitative losses in different cabbage producing areas. The use of pesticides is the predominant control measure applied to control these pests but causing several disadvantages, such as development of resistance in insect pests against these insecticides and health hazards for non-target organisms including pollinators, biological control agents and humans. The present study was conducted to assess seasonal qualitative and quantitative losses by insect pests in different crop production systems of cabbage. The cabbage was sown during middle of September and end of November in different plots and each plot had an area of 10×15 ft. The plant to plant and row to row distance was 0.84 ft. and 2.4 ft. respectively. The treatments like integrated pest management (IPM), black mulch, reduce risk pesticides and growers standard was used during the study under randomized complete block design (RCBD). The quantitative and qualitative pre and post treatment data was collected at weekly bases and compared with the control to find out the effective production system. Finally data was analyzed with suitable statistical technique. The results revealed IPM and reduce risk pesticides treatments showed less qualitative and quantitative losses than other treatments. Among all treatments, the control had more quantitative and qualitative losses due to improper management and environmental hazards. Insect pests caused more quantitative losses than qualitative losses.

Key words: Cabbage, Quantitative and qualitative losses, Integrated pest management (IPM), Black mulch, Reduce risk pesticides, Growers standard
Received: 02-March-2016, Accepted: 07-May-2016

Introduction

During the last decade, organic agriculture has gained recognition as an alternative to the conventional practices. It aims at "cooperating rather than confronting with nature". It reduces cost of production, preserve the environment and protect human health by eliminating the use of toxic agro chemicals (Ambika and Kurian, 2004). Vegetables are grown all over the world for their nutritional value, taste and cuisine. Global vegetable production was 965.65 million tons in 2010 and continues to grow in order to meet an ever increasing consumer demand (FAOSTAT, 2012). All cole crops have originated from Europe and have risen from a single crop called colewarts or wild cabbage. The cole crops are cultivated all over the world from Arctic to Subtropical regions and at higher altitudes of tropics (Hill, 1975). Cabbage is the very important cole crop which grows in calm weather. The value of ripened portion of cabbage comprises 1.8g protein, o.1g fat, 4.6g carbohydrate, 0.6g mineral, 29mg Ca, besides enriched in Vitamin A and C. (Tiwari *et al*., 2003).

Being an agricultural country, Pakistan produces almost all vegetables including cabbage. Pakistan has produced 0.072 million tons of cabbage including other crucifers on 0.0043 million hectares (FAO, 2010). Total area under its cultivation in Pakistan is 0.012 mha with an annual production of 0.18 mha (Muhammad, 2005). In Punjab area under cultivation was 0.018 million hectares during 2011-2012 with annual production of 0.021 million tons. The yield of cabbage is vulnerable by destruction and competition from pests, particularly when this is grown on large area or with deep application of fertilizer (Cooke, 1998). Among all these groups of insects, aphids constitute one of the important groups of insects belonging to order Homoptera, superfamily Aphidoidea and family Aphididae. It affects both quality and quantity of crop either affecting plant width, plant height and yield. The aphid is also a vector of semipersistant, 4 persisitant and 11 non-persistent plant viruses (Ulusoy and Bayhan, 2006).

Among other insect pests, diamond back moth, *Plutella xylostella* L. is also important pests that causes considerable loss each year in cabbage

(Patra *et al*., 2013). For many years, diamond back moth (DBM) has been considered to be the most important pest of brassica crops including cabbage worldwide (Talekar and Shelton, 1993), costing up to 1billion US$ per year in damage and cost of control (Javier, 1992). Cabbage looper, *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae), is a migratory insect pest of subtropical area and mainly concern in North America and cause qualitative and quantitative losses and very rare losses are found in our country but the major threat is occuring in tropical and subtropical area of Pakistan and it mostly damage the leaf and shoots (Franklin *et al*., 2010). Army worm, *Spodoptera litura*, has the ability to cause excessive damage to these crops ranging from 26 to 100 percent by its vigorous defoliation (Dhir *et al*., 1992). *S. litura* has developed medium to high levels of resistance against all types of insecticides which are commonly used for the control of this pest in Pakistan (Ahmad *et al*., 2007).

Vegetable weevil cause more damage in cabbage crop but the mostly damage was observed on its leaves that shows that it increases its damage pattern and affects yield and plant health which affects the quantity and quality of crop (Bano *et al.*, 1996). The scope of production systems which are uses for cabbage production are to promote the quality, safety of cabbage, improve productivity and profitability of cabbage, controlling the cost of production and improved field drainage (Tilman, 1999). These production systems improved marketing and packaging, increasing consumer trend for buying local produce, knowledge on the part of retail marketers of how to handle cabbage. (Oerke *et al*., 1994). Processing operations such as spillage, abrasion, excessive polishing, peeling and trimming can also add to loss of commodity (Hodges *et al*., 2011). Keeping in view, the present study was done to evaluate the efficiency of different cabbage growing systems for cabbage production with minimum quantitative and qualitative losses.

Materials and Methods

Experiment Layout and Treatment Applications

The experiment was conducted on Entomological Research area Youngwala,, University of Agriculture Faisalabad, Pkistan. In this experiment, the plant-to-plant and row-to-row distances were kept of 0.84 ft. and 2.4 ft. respectively. The experiment was comprised of five treatments given 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 10 ×15 ft whereas total experimental area was 1 kanal. 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.

The list of treatment with detail is given in Table 1. In IPM plot all control measures such as, mechanical, cultural and chemical control was applied. In case of mechanical control, different traps like yellow sticky trap were used to control the insect pests. 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 pesecticide treatment, insecticide was applied as control measures. For this purpose, emamectin and pyriproxyfin were applied in the field. In grower standard, imidacloprid and lambda cyhalothrin were applied. Lambda cyhalothrine 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.

Qualitative Data

In qualitative data, plant height, plant width was checked.

Quantitative Data

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

Percent damaged leaf =

(No. of leaves having eating symptoms / Total leaves of plant) × 100

Results and discussion

The minimum leaf damage percentage was observed in RRP (4.51%) treatment and this percentage was maximum in control treatment (41.01%). After that this percentage was lower in IPM (7.14%), grower standard (12.18%) and black mulch (27.26%). So this damage was lower in RRP due to application of different crop production strategies and the maximum height was observed in grower standard (37.24%) treatment after that it was observe in IPM (32.41%), reduce risk pesticides (29.51%) and black mulch (26.31%). The minimum height was observed in control treatment (24.87%). All the treatment had significant results. But in case of plant width the maximum plant width was observed in IPM (29.76%) treatment after that it was observed in grower standard (27.67%), reduce risk pesticides (26.21%) and black mulch (24.37%). The minimum width was observed in control treatment (23.76%). All the treatments had significant results and in case of yield the maximum yield of cabbage was observed in IPM (4.67%) that is 0.04 times more than other treatments and after that it was observed in grower standard (4.10%), reduce risk pesticides (3.80%) and control (3.57%). But the minimum yield was observed in black mulch (2.73%) treatment. Therefore IPM was best treatment according to production Table (2).

In present findings, all treatments showed significant differences and the IPM treatment proved to be best in majority of parameters (Table 2). In case of quantitative losses, the maximum leaf percent damage was observed in control treatment because in this treatment control practices were not applied. So the maximum leaf damage was observed in control treatment. Minimum leaf damage percentage was observed in reduce risk pesticides because in RRP the chemical and cultural control measures were applied. In case of yield the IPM and grower standard treatments reduced pest populations and damage, resulting in a better yield than the other treatments (Figure 1). The use of IPM was also environmental friendly and low cost observed in IPM treated plot and RRP which was in accordance with the findings of Hanchinal *et al*. (2009) and Gahukar (2000). The use of IPM also decreased the pesticides usage because the infestation of insect pests was very low. Maximum insect pest reduction percentage was observed when control measures were applied by using chlorpyrifos and thiacloprid at ETL of insect pests. The incorporation of these two insecticides (chlorpyrifos and thiacloprid) in IPM is in accordance with previous work done against different insect pests of cabbage (Leibee and savage, 1992; Mitchell *et al*., 1997; Shah and Abduallah, 2000). The results indicated that IPM and reduce risk pesticides treatments was found to be most effective for cabbage yield as observed by Musser *et al*. (2005) who found IPM practices best for the management of cabbage insect pests. Both qualitative (plant height and plant width) and quantitative (yield and leaf percent damage) losses caused by the misuse and excessive use of insecticides that cause résistance in insect pests which was in accordance with the finding of Hirai (1993) concluded that misuse of chemical insecticides might be accountable for the outbreaks of the pest because extensive and intensive use of insecticides exert more selection pressure on target pests and accelerate resistance development. High intensity of insecticide sprays causes mortality of beneficial arthropods associated with predation or parasitism and pollination.

The present findings shows that reduce risk pesticides and IPM is better than other treatments because less qualitative and quantitative losses were observed in these treatments. From all these treatments the control and black mulch treatments had more quantitative and qualitative losses due improper management and environmental hazards and plant height and plant width also affected due to above both factors and according to the Debraj and Singh (2003) cabbage sown during Summer, had less yield and its quantity is also decrease as compared those crop that planted in winter and spring. But the winter season cabbage is the best in quantity because during its planting season it was less influenced by environment hazards.

Both qualitative and quantitative losses are 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.

In conclusion, the qualitative and quantitative losses were minimum in IPM and reduce risk pesticides. But, the insecticides used in IPM reported to have side effects on the environment and non-target organisms. Therefore, it is recommended to further investigate the combination of IPM with reduced risk pesticides to control the insect pests. Reduced risk pesticides are target specific and less hazardous to non-target organisms i.e., natural enemies of insect pests. This way both IPM techniques and reduced risk pesticides could have synergistic impact for the management of insect pests because the natural enemies will also play an important role to manage the insect pests due to the use of target specific reduced risk pesticides.

Conclusion

The results revealed IPM and reduce risk pesticides treatments showed less qualitative and quantitative losses than other treatments. Among all treatments the control treatment had more quantitative and qualitative losses due to improper management and environmental hazards. Insect pests caused more quantitative losses than qualitative losses. We conclude that the quantitative losses which caused by different insect pest had more losses than qualitative losses. But in case of quantitative losses we can easily overcome these losses at initial stage by using different crop protection system than qualitative losses. In all parameters the RRP was best in majority cases than other treatments either in quality and quantity of cabbage crop.

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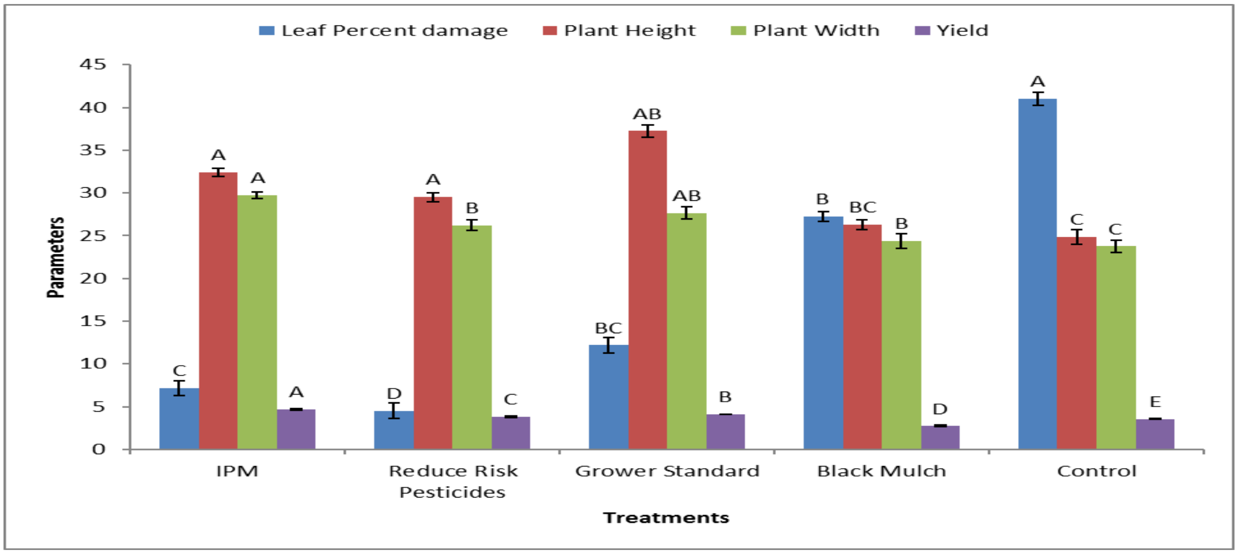

Fig.1 The graphs represents that IPM and reduce risk pesticides treatments is better than other treatments and best for production.

Table 1: List of treatments and their detail

Treatment No.	Treatments Name	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

Table 2: Impact of crop production systems on qualitative and quantitative losses of cabbage

Treatments	Means			
	Leaf Percent Damage	Plant Height	Plant Width	Yield
IPM	7.140 ± 0.87^{C}	32.416 ± 0.47^{A}	29.761 ± 0.39^{A}	4.6745 ± 0.07^{A}
Reduce Risk Pesticides	$4..517 \pm 0.91^{D}$	29.510 ± 0.52^{A}	26.213 ± 0.63^{B}	3.8057 ± 0.09^{C}
Grower Standard	12.180 ± 0.87^{BC}	37.243 ± 0.72^{BC}	27.674 ± 0.71^{AB}	4.1045 ± 0.04^{B}
Black Mulch	27.264 ± 0.57^{B}	26.312 ± 0.56^{BC}	24.370 ± 0.82^{B}	2.7345 ± 0.08^{D}
Control	41.017 ± 0.81^{A}	24.875 ± 0.88^{C}	23.764 ± 0.73^{C}	3.5767 ± 0.09^{E}