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Assessment of avoidable yield losses in crop brassicas by insect-pests

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Abstract
A five years' field study was carried out to assess the avoidable yield losses in *Brassica juncea* and *B. rapa* due to insect-pests from 2011-12 to 2015-16 crop seasons at the Oilseeds Research Farm of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India. The experiment was laid out in a randomized block design with three replications and two sets viz. protected and unprotected. The protected set was sprayed with thiamethoxam 25 WG @ 100 g ha^{-1} and dichlorvos 85 SL @ 500 ml ha^{-1} against mustard aphid and cabbage caterpillar, respectively. Data on the insect-pests were recorded at weekly intervals while yield data were recorded at harvest. The loss in seed yield due to mustard aphid and cabbage caterpillar infestation varied from 18.3 to 24.5 per cent. The two *B. juncea* varieties NRCDR 2 and PBR 91 suffered about 24 per cent yield loss and harboured significantly higher mustard aphid and cabbage caterpillar population than *B. rapa* BSH 1 which suffered 18.3 per cent yield loss.

Keywords: *Brassica juncea, Brassica rapa, Lipaphis erysimi,* Turnip aphid, *Pieris brassicae*, pest damage

1. Introduction
Oilseed brassicas, also known by their trade name rapeseed-mustard, are important source of vegetable oil for human consumption [9, 10]. In India, these energy rich crops are grown under energy deprived conditions with little inputs which limits the realization of full yield potential of these crops. In addition, a number of biotic and abiotic stresses further add in reducing the yield [10]. Among these, the attack of insect-pests is the major limiting factor in reducing the yield. A number of insect-pests are known to be associated with this crop right from sowing till harvest out of which only a few cause serious losses. Kular and Kumar [7] reported that losses in seed yield due to attack of insect-pests vary from 6.5 to 26.4 per cent on different *Brassica* spp. According to Dhaliwal *et al*. [5] rapeseed-mustard in India generally suffer 30 per cent yield loss due to insect-pests amounting to 27300 million of Indian rupees annually (approximately US$ 600 millions). The mean yield loss due to aphid infestation alone varies from 35.4 to 73.3 per cent depending on the agroclimatic conditions and averages 56.2 per cent across all of India [2]. In mustard the oil yield loss is estimated to be 32 per cent [16].
The estimation of crop damage due to insect-pests is important since it provides updated information about the amount of damage inflicted to crops by different insect-pests, helps in assigning priorities based on the relative importance of insect-pests, for deciding the allocation to research and extension in plant protection and for evaluating crop varieties for their susceptibility/resistance to insect-pests [5]. Under the agro-climatic conditions of Punjab, rapeseed-mustard is generally seriously attacked by mustard aphid, *Lipaphis erysimi* (Kaltenbach) [1, 8] and the cabbage caterpillar, *Pieris brassicae* (Linnaeus) [10]. Therefore, a five years' study was undertaken to assess the amount of damage suffered by oilseed Brassica due to insect-pests.

2. Materials and Methods
The study was conducted for five crop seasons from 2011-12 to 2015-16 at the Oilseeds Research Farm of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana (30.9°N, 75.85°E, 244 m above msl), India. The experiment was laid out in randomized complete block design with two different sets viz. protected and unprotected. There were three different genotypes belonging to two species viz. *Brassica juncea* var. PBR 91 and NRCDR 2 and *B. rapa* cv. BSH 1. Sowing was deliberately delayed than the normal

sowing in October and was done in second week of November since late sown crop is attacked more by insect-pests. The plot size was kept at 4.2 x 3.0 m with six replications for each genotype three each for protected and unprotected sets. The protected set was sprayed with thiamethoxam 25 WP @ 100 g ha^{-1} and dichlorvos 85 SL @ 500 ml ha^{-1} to control mustard aphid and cabbage caterpillar, respectively, which are the two predominant pest species on rapeseed-mustard in this part of the country. The unprotected set was sprayed with water only at the time of insecticide spray on protected set.

At the time of pest appearance, 10 plants from each plot were selected at random and data on the number of aphids and cabbage caterpillars were recorded at weekly intervals. The data on aphid counts were recorded from top 10 cm apical portion of central twig of the plant as per Bakhetia and Sandhu [4] while that on the larval counts were recorded on whole plant basis. The yield data from protected and unprotected plots were recorded at harvest of the crop and per cent loss in seed yield computed. The data on the pest incidence and seed yield for the five years were pooled together to have an overall picture of the loss in seed yield due to pest attack.

3. Statistical Analysis

The data on the pest incidence and yield were subjected to analysis of variance (ANOVA) using the statistical software OPSTAT [13]. The level of significance was set at 5 per cent. Wherever, the differences among means were significant, means were separated by LSD.

4. Results and Discussion

4.1 Aphid population

In 2011-12 crop season, the population of mustard aphid varied from 53.6 to 110.9 aphids $plant^{-1}$ on different genotypes while it remained below economic threshold level of 50-60 aphids $plant^{-1}$ in the protected set. The maximum population of 144.1 aphids $plant^{-1}$ was recorded on PBR 91 followed by that on NRCDR 2 (110.9 aphids/ plant) (Fig. 1). However, the aphid population on BSH 1 (53.6 aphids/ plant) was significantly lower than that on the other two genotypes.

In 2012-13 crop season, a trend similar to that in 2011-12 crop season was observed, however, in general the aphid pressure remained low throughout the crop season and it never exceeded economic threshold level.

In 2013-14, a heavy pressure of mustard aphid was witnessed. The maximum population of 135.0 aphids $plant^{-1}$ was recorded on NRCDR 2 in unprotected set followed by PBR 91 (61.0 aphids/ plant) which was significantly lower than that on NRCDR 2. However, no population build up was recorded on BSH 1. The protected set remained free from aphid infestation. The 2014-15 crop season also witnessed very low population build up of mustard aphid and hence no interpretation could be drawn.

Aphid pressure in 2015-16 crop season was very high and the maximum population of 266.8 aphids $plant^{-1}$ was recorded on PBR 91 followed by NRCDR 2 and BSH 1 (202.7 and 100.3 aphids/ plant, respectively).

From the pooled data of five years, it is evident that PBR 91 harboured the maximum population of 90.3 aphids $plant^{-1}$ followed by NRCDR 2 (70.8 aphids/ plant) in unprotected set which was at par with that on PBR 91. The minimum population of 35.0 aphids $plant^{-1}$ was recorded on BSH 1 which was significantly lower than the other two genotypes.

4.2 Cabbage caterpillar/Large white butterfly larval population

In 2011-12 crop season, cabbage caterpillar population ranged from 0.0 to 27.0 larvae $plant^{-1}$ in the unprotected set while the protected set was free from caterpillar infestation (Fig. 2). The maximum population of 27.0 larvae $plant^{-1}$ was recorded on PBR 91 followed by NRCDR 2 (21.1 larvae/ plant) which were at par with each other. However, BSH 1 remained free from cabbage caterpillar infestation throughout the crop season.

The 2012-13 crop season witnessed low incidence of cabbage caterpillar. The maximum caterpillar population of 7.0 larvae $plant^{-1}$ was recorded on NRCDR 2 which was significantly higher than that recorded on PBR 91 and BSH 1 (2.3 and 1.2 larvae/ plant, respectively) in unprotected set. The protected set was free from caterpillar infestation.

In 2013-14 crop season maximum population of 49.0 larvae $plant^{-1}$ was recorded on NRCDR 2 followed by 34.7 larvae $plant^{-1}$ on PBR 91 in unprotected set which were at par with each other. However, BSH 1 harboured minimum population of 3.5 larvae $plant^{-1}$ which was significantly lower than the other two genotypes. The protected set was free from caterpillar infestation.

Very low population of cabbage caterpillar was recorded in 2014-15 crop season. The highest population of only 3.5 larvae $plant^{-1}$ was recorded on NRCDR 2 in unprotected set which was significantly higher than the other two genotypes viz. 2.1 and 0.5 larvae $plant^{-1}$ on PBR 91 and BSH 1, respectively. The protected set was free from caterpillar infestation.

Like 2014-15, 2015-16 crop season also witnessed very low population of this pest. While BSH 1 was free from caterpillar infestation, the maximum population was only 2.7 larvae $plant^{-1}$ on PBR 91 which was at par with that on the NRCDR 2 (2.4 larvae/ plant).

The pooled data of five years revealed that NRCDR 2 harboured maximum larval population (33.8 larvae/ plant) which was significantly higher than that on PBR 91 (19.02 larvae/ plant) and BSH 1 (0.34 larvae/ plant).

4.3 Avoidable yield loss

In 2011-12, loss in seed yield by insect-pests varied from 9.2 to 26.9 per cent on different genotypes (Fig 3). Maximum yield loss (26.9%) was recorded in PBR 91 followed by NRCDR 2 and BSH 1 (21.7 and 9.7%, respectively). It is evident from data in Fig 1 and 2 that maximum yield loss in PBR 91 corresponded with maximum population of mustard aphid (144.1 aphids/ plant) and cabbage caterpillar (27.0 larvae/ plant) under unsprayed conditions. Similarly, 21.7 per cent yield loss in NRCDR 2 corresponded with 110.9 aphids and 21.1 cabbage caterpillars $plant^{-1}$. The yield loss in BSH 1 was the minimum (9.7%) which harboured minimum aphid population (53.6 aphids/ plant) and no caterpillar infestation.

In 2012-13, yield loss among different genotypes varied from 7.8 to 16.3 per cent. Maximum yield loss of 16.3 per cent was recorded in NRCDR 2 followed by PBR 91 (8.3%) and BSH 1 (7.8%). In NRCDR 2, the maximum yield loss corresponded with the highest cabbage caterpillar population of 7.0 larvae $plant^{-1}$ while aphid population was non-significant among the genotypes and was below economic threshold level of 50-60 aphids $plant^{-1}$. The other two genotypes also followed the trend similar to that observed for yield loss with 2.3 and 1.2 cabbage caterpillars $plant^{-1}$ on PBR 91 and BSH 1, respectively.

Yield loss in 2013-14 varied from 11.5 to 25.1 per cent in the three genotypes. Genotype NRCDR 2 recorded the maximum loss in seed yield (25.1%) followed by PBR 91 (14.7%) and BSH 1 (11.5%). The maximum yield loss in NRCDR 2 corresponded with the maximum population of mustard aphid (135.0 aphids/ plant) and cabbage caterpillar (49.0 larvae/ plant) under unsprayed conditions. Similarly, minimum yield loss in BSH 1 corresponded with no aphid population and low cabbage caterpillar population (3.5 larvae/ plant).

In 2014-15, yield loss varied from 6.5 to 18.6 per cent among the genotypes. The maximum loss in seed yield was recorded in NRCDR 2 (18.6%). It was followed by 11.8 and 6.5 per cent in PBR 91 and BSH 1, respectively. As observed earlier, the maximum yield loss in NRCDR 2 corresponded with the maximum cabbage caterpillar population of 3.5 larvae plant^{-1}, while the aphid population was very low and was non-significant among the genotypes. Likewise, the minimum yield loss in BSH 1 corresponded with the minimum cabbage caterpillar population of 0.5 larvae plant^{-1}.

In 2015-16, loss in seed yield among the genotypes varied from 42.3 to 53.7 per cent. Genotype PBR 91 suffered the maximum yield loss (53.7%) followed by 46.6 and 42.3 per cent in BSH 1 and NRCDR 2, respectively. The maximum yield loss in PBR 91 corresponded with the maximum population of mustard aphid (266.8/ plant) and cabbage caterpillar (2.7 larvae/ plant).

From the pooled data of five years it is evident that loss in seed yield due to insect-pests ranged from 18.3 to 24.5 per cent. Genotype NRCDR 2 suffered the maximum yield loss of 24.5 per cent followed by 24.2 and 18.3 per cent in PBR 91 and BSH 1, respectively. The maximum yield loss in NRCDR 2 corresponded with the maximum cabbage caterpillar population of 33.8 larvae plant^{-1} followed by PBR 91 and BSH 1 (19.02 and 0.34 larvae/ plant, respectively) which were significantly different from each other. These two *B. juncea* genotypes (PBR 91 and NRCDR 2) also harboured very high aphid population (90.3 and 70.8 aphids/ plant, respectively) which was at par on these two genotypes but significantly higher than that recorded on BSH 1 (35.0 aphids/ plant).

Sahoo [12] reported that losses in seed yield in crop Brassicas due to attack of insect-pests ranged from 34.62 to 59.33 per cent. Similarly, Patel *et al.* [11] reported that *B. juncea* generally suffer very high yield loss due to attack of mustard aphid under unprotected conditions which may range from 76.0 to as high as 100.0 per cent. Singh and Sachan [14] reported upto 69.6 per cent loss in seed yield of oilseed Brassica due to mustard aphid, while Bakhetia [3] reported it to range from 57.8 to 80.6 per cent and Suri *et al.* [17] reported about 42.0 per cent yield losses under different agroclimatic conditions. Jadhav and Singh [6] also reported that similar results. In Haryana, Singh *et al.* [16] reported 38.20 to 46.56 per cent yield losses due to insect pests under unprotected conditions. In an earlier study at the same institute, Kular and Kumar [7] reported 6.5 to 26.4 per cent yield losses due to mustard aphid and cabbage caterpillar infestation. *Brassica rapa* genotype BSH 1 is generally susceptible to mustard aphid but it suffered comparatively less damage than the other two *B. juncea* genotypes due to its early maturity which results in a general lack of synchronization between the peak period of aphid activity and the most susceptible flowering stage of the crop. By the time cabbage caterpillar population started building up; the genotype has already crossed the pod formation stage and progressed towards maturity. Though, caterpillar can still feed at the pod formation stage but the population rarely develops on BSH 1 due to the availability of more suitable hosts from other *Brassica* species. Thus, the results reported in the present study are similar to those reported by earlier workers, however, the variation in yield losses could be attributed to different levels of insect infestation.

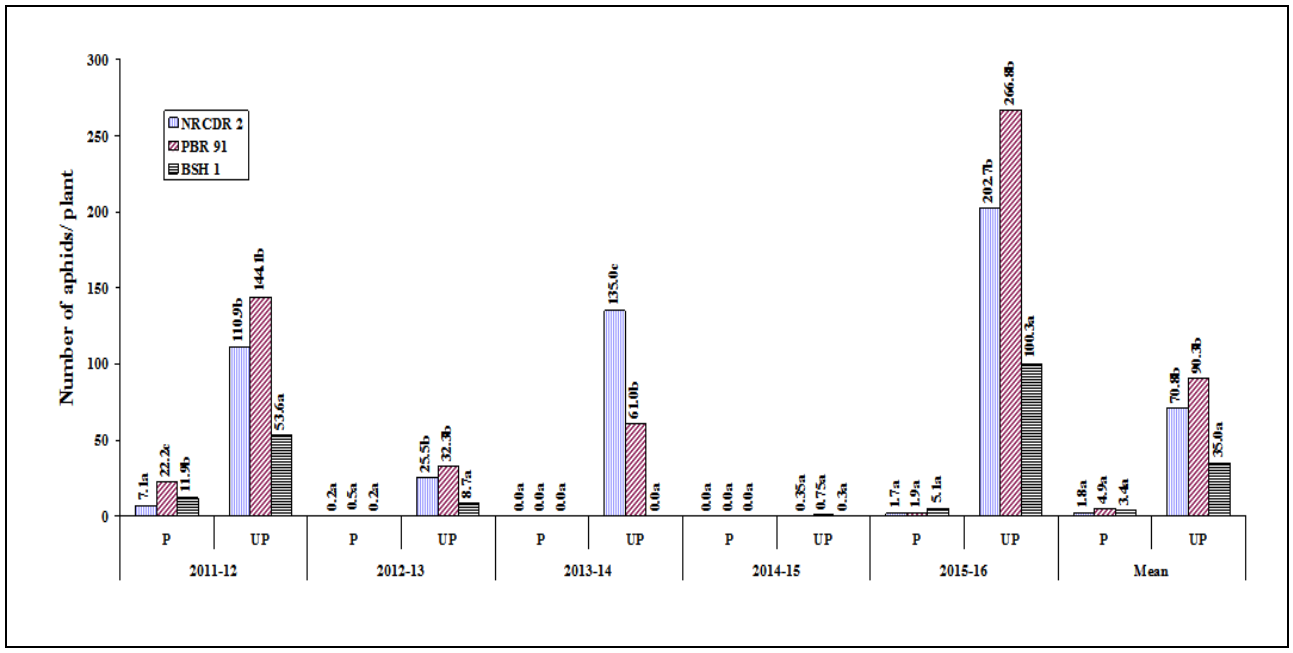

Fig 1: Comparative population of *Lipaphis erysimi* on different *Brassica* genotypes during 2011-12 to 2015-16 crop seasons Bars with values followed by different letters are significantly different at p=0.05 P: Protected with insecticides; UP: Unprotected

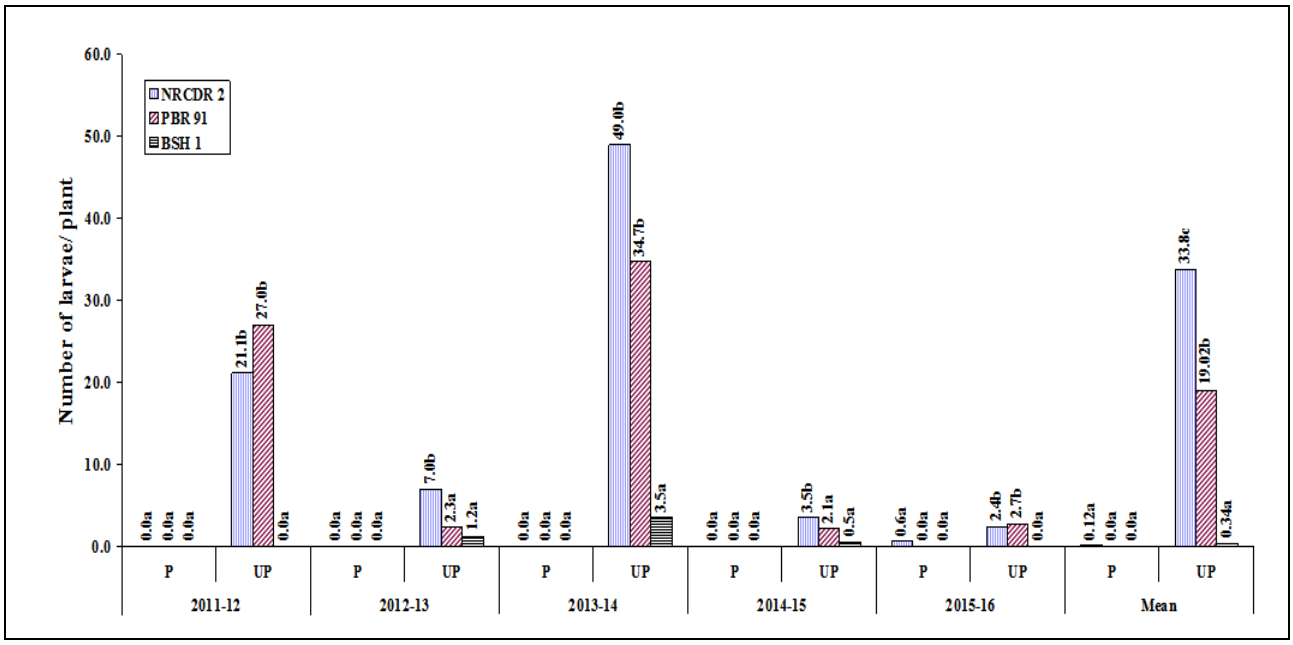

Fig 2: Comparative population of *Pieris brassicae* on different *Brassica* genotypes during 2011-12 to 2015-16 crop seasons Bars with values followed by different letters are significantly different at p=0.05 P: Protected with insecticides; UP: Unprotected

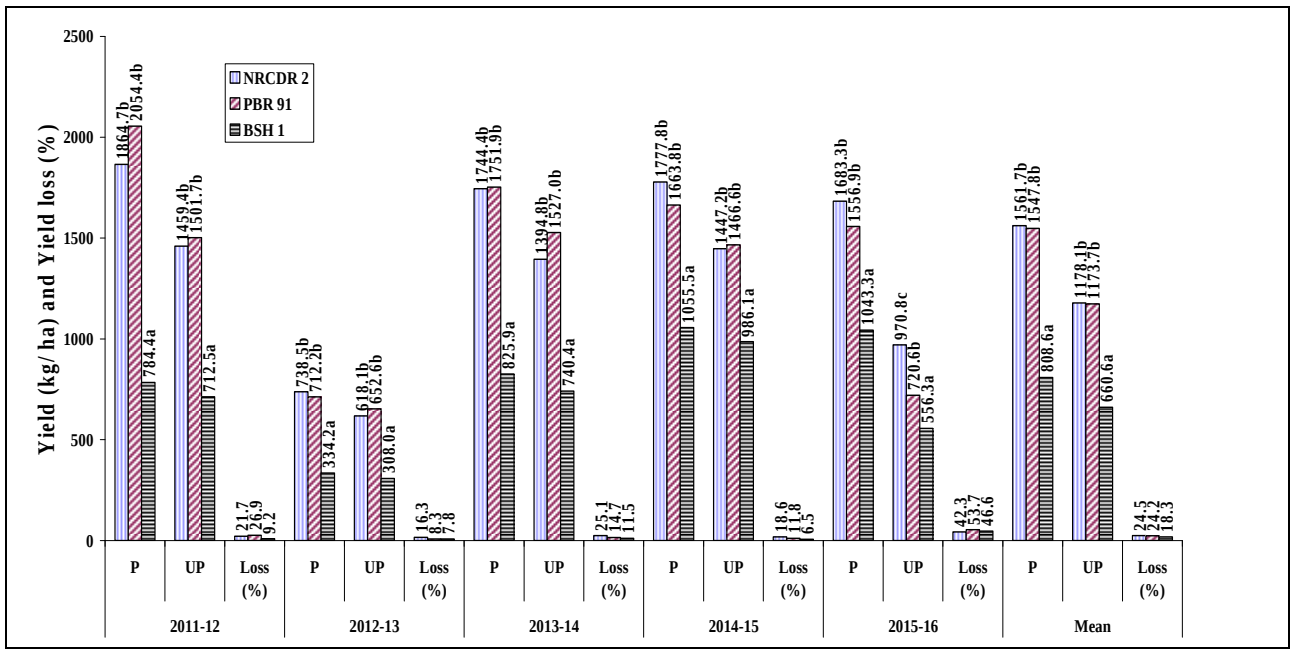

Fig. 3: Comparative yield and loss in seed yield in different *Brassica* genotypes during 2011-12 to 2015-16 crop seasons
Bars with values followed by different letters are significantly different at p=0.05
P: Protected with insecticides; UP: Unprotected

5. Conclusion

It can be concluded from this study that under agroclimatic conditions of Punjab, yield losses in crop Brassicas by insect-pests, particularly mustard aphid and cabbage caterpillar, vary from 18.3 to 24.5 per cent. Two *Brassica juncea* varieties NRCDR 2 and PBR 91 suffered about 24 per cent loss in seed yield while *B. rapa* cv. BSH 1 suffered 18.3 per cent loss.

6. Acknowledgement

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7. References

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