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Adoption level and impact of weed management technologies in rice and wheat: Evidence from farmers of India

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ABSTRACT

Weed invasions change the natural diversity and balance of ecological communities which threaten the survival of many plants and animals. Therefore, weed management is important as far as crop production is concerned. Further, impact assessment has been proven as a means of measuring the effectiveness of any agricultural technology in improving productivity, reducing the poverty and increasing the livelihood security of the farmers. Present study focuses on highlighting socio-economic status of the farmers and agencies which play significant role in dissemination of weed related information as well as effect of weed management technologies on weed intensity in rice and wheat crops. Results revealed that before adoption, some weeds like *Cyperus difformis, Fimbristylis milliacea* and *Ludwigia parviflora* were found in very high severity (>75%) level in rice, however, after adoption of improved weed management technologies they reached to low and moderate severity (<50%) in farmers' fields. According to 4.3% of the farmers, *Phalaris minor* is still present in wheat with very high level of severity (>75%) in most of their fields. Analytic Hierarchy Process (AHP) revealed the major agencies which play important role in disseminating the weed management technologies to the farmers. Findings of study stress on sensitizing different agencies and increasing their role in dissemination of weed management solutions to the farmers.

INTRODUCTION

It is accepted at all levels that weeds are destructive, troublesome, and competitive plants within croplands. Unlike the other pests, weeds grow in a similar trophic level with crop plants, and cause enormous yield losses as a result of strong competition with them for scarce resources (Ramesh *et al*. 2017). Weed invasions change the natural diversity and balance of ecological communities and these changes threaten the survival of many plants and animals (Pysek *et al*. 2012). Therefore, weed management is important as far as crop production is concerned. Keeping in view the importance of weed management in India, many government/non-government agencies are involved in disseminating weed management technologies to the farmers. However, impact of these interventions are of great importance as increasing attention to aid effectiveness of the technology has increased emphasis on establishing quantifiable impacts on productivity of farm as well as livelihood security of the farmers over the last decade. Impact assessment has been proven as a means of measuring the effectiveness of any agricultural technology in improving productivity, reducing the poverty and increasing the livelihood security of the farmers. So, present study focuses on highlighting socio-economic status of the farmers and agencies which play significant role in dissemination of weed related information as well as effect of weed management technologies on weed intensity.

MATERIALS AND METHODS

Present work was carried out at ICAR-Directorate of Weed Research, Jabalpur during 2014-17. Total 412 respondents were selected using purposive sampling and information was collected using interview schedule from different states of India through centre of All India Coordinated Research Project on Weed Management. Respondents belong to 18 states, *viz*. Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal. Using the agro-ecological zones characteristics, groups were formed of those states which fall in same agro-ecological Zone. Details of groups are given (**Table 1**).

Table 1. Groups comprising the states of India

Group	States
Group I	Gujarat, Haryana, Part of Madhya Pradesh (Gwalior), Punjab, Uttar Pradesh
Group II	Karnataka, Part of Maharashtra (Dapoli), Telangana
Group III	Part of Madhya Pradesh (Jabalpur)
Group IV	Bihar, Jharkhand, Odisha, West Bengal
Group V	Himachal Pradesh, Uttarakhand

Information on awareness and adoption level of farmers on weed management was collected through some questions. These questions were quite enough to explain the importance of weed management in current era with farmers' point of view. They were based on different aspects such as (i) weeds as major obstacle (ii) importance of weed management in traditional farming system (iii) adoption of IWM (improved weed management) at farmers' level and (iv) their knowledge on preventive method of weed management. Information was also collected on their knowledge on chemical method of weed control. Different aspects include (i) use of precautionary measures during spraying (ii) awareness on spurious chemical and their availability in the market (iii) use of right type of nozzle for herbicide spray (iv) mixing of herbicides with other chemical.

Data analysis and interpretation were performed using some statistical tools such as descriptive statistics and Analytical Hierarchy Process (AHP). For some questions, respondents were requested to give their answers in descriptive way which were presented in percentage form.

Use of AHP for selection of appropriate agency

Analytic hierarchy process (AHP) as illustrated by Giri and Nejadhashemi (2013) and Young *et al.* (2010) was used for selection of best agency disseminating the weed management technologies to the farmers of India. AHP was first developed by mathematician Thomas L. Saaty (Saaty 1980). It is an algorithm able to assist complex decision-making problems. Major characteristic of AHP is that, although it deals with complex matrix, it can be used successfully without having much knowledge of multi-criteria decision-making theory. The AHP works on developing priorities for alternatives available based on the criteria used to judge the alternatives.

RESULTS AND DISCUSSION

Socio-economic profile of the respondents in the sample

Educational level: Results showed that 46% of the farmers were educated upto secondary level across the groups, however, some of them (17.7%) were also under-graduate. Group I had slightly higher percentage of respondents educated upto secondary level (53.3%), however, 23% of the respondents were educated upto middle. On the other hand, a reverse trend was observed in Group II where, big proportion of them (45.7%) were educated only upto primary level and 17% of them were educated upto secondary level. All other groups follow the same trend as present in combined data. Data also showed that 6.3% of them were illiterate and had no formal education indicating relatively high literacy rate among selected farmers. The trend was similar across the groups except in the case of Group II where 20% of them were illiterate. It is expected that educated farmers are more inclined to adoption of any new technologies than any less educated or illiterate farmer (Okoye *et al.* 2004, Ajibefun and Aderinola 2004, Udensi *et al.* 2012). Thus, education helps farmers to decide to adopt modern technology and thereby, increase output. To be brief, old economic theories assume that education is a catalyst of production. However, new theories (endogenous growth models-Romer 1986 & 1990; Lucas 1988) have given more importance on the knowledge level of human capital (Dev and Hussain 1996).

Primary occupation: Across groups, more than 95% of the respondents had agriculture as the main occupation and source of income except in Group V where, 82% farmers practicing agriculture as their primary occupation and remaining as their secondary source of income.

Farming experience: Among all respondents, almost half (48.7%) of the farmers have 15-30 years of experience and the trend was similar in all groups except Group II where 37% of the farmers carrying the 15-30 years of experience. Owing to the risk involved by adopting a new technology, a farmer with more experience may be adopter or non-adopter because this variable may affect the farmer's decision positively or negatively in adopting any chemical method of weed control (Udensi *et al.* 2012).

Annual income: Annual income is also one of the factors which affect the adoption level of farmers. Farmers with more annual income are expected to be early and fast adopters due to their risk bearing ability. In the study, average annual income of the respondents were calculated as ₹ 263458/- which is expected to be earned from their primary occupation *i.e.* farming. However, more than half of the respondents (55%) have income less than ₹ 2 lakh.

Total owned land: It was observed that average land holding was 7 acres across groups. Among all, 37% respondents owned land less than 2.5 acres. However, average owned land was quite high in

Group I and Group III with 11.7 and 11.9 acres, respectively. On the other hand, in Group II and V, more than 70% of the respondents have land less than 2.5 acres. However, maximum farmers from Group I and III owned land more than 10 acres.

Area under cultivation: As 37% of respondents owned land less than 2.5 acres, 49% of the total respondents cultivate the area less than 2.5 acres. Remaining farmers were distributed evenly in other three categories.

Effect on weed intensity as affected by adoption of weed management technologies

Weeds act as an impediment to food security and national economic growth (Vanco and Akan 2005, Udensi *et al*. 2012). It is widely known, in most cases, losses caused by weeds exceeded the losses from any category of agricultural pests (Gharde *et al.* 2018). This is an assumption that if all the weeds in food crops were controlled, the current world's food production would be higher by 10 to 25% (Rao 2000, Abouziena and Haggag 2016). In the present study, in order to understand the severity of weeds in the farmers' fields before and after the adoption of weed management technologies, farmers were asked to mention the major weeds of rice and wheat crops and rate the severity of weeds using 4-point Likert scale; 1= low (0-25%), 2= moderate (25-50%), 3=high (50-75%), 4= very high (>75%). The severity was recorded for the field situation before and after the adoption of weed management technologies in rice (**Figure 1**) and wheat (**Figure 2**).

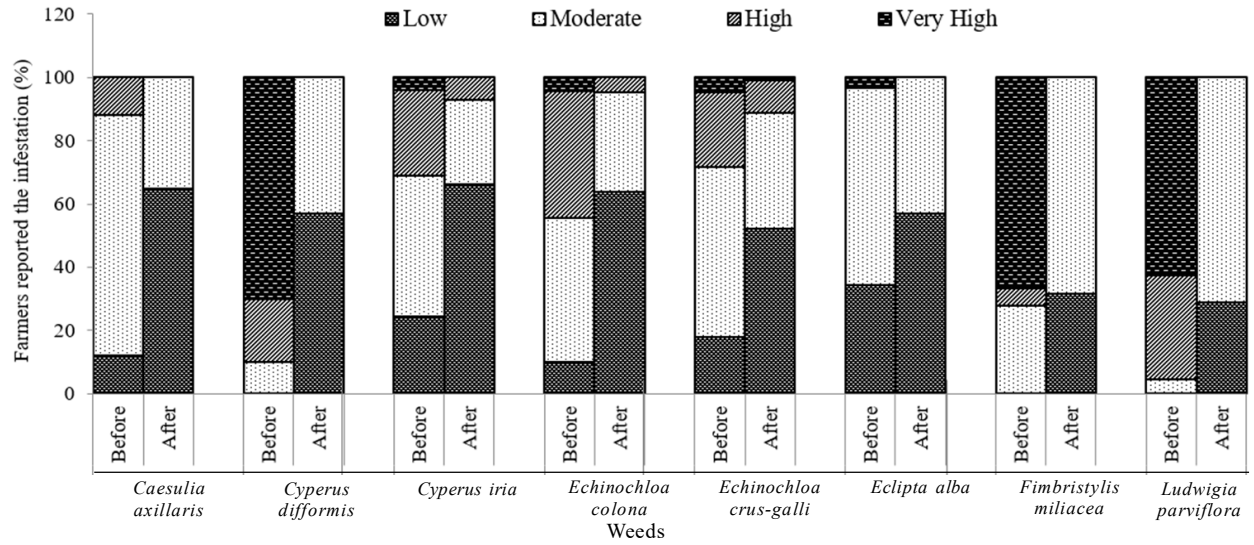

Figure 1. Response of farmers on weed severity (%) in rice crop

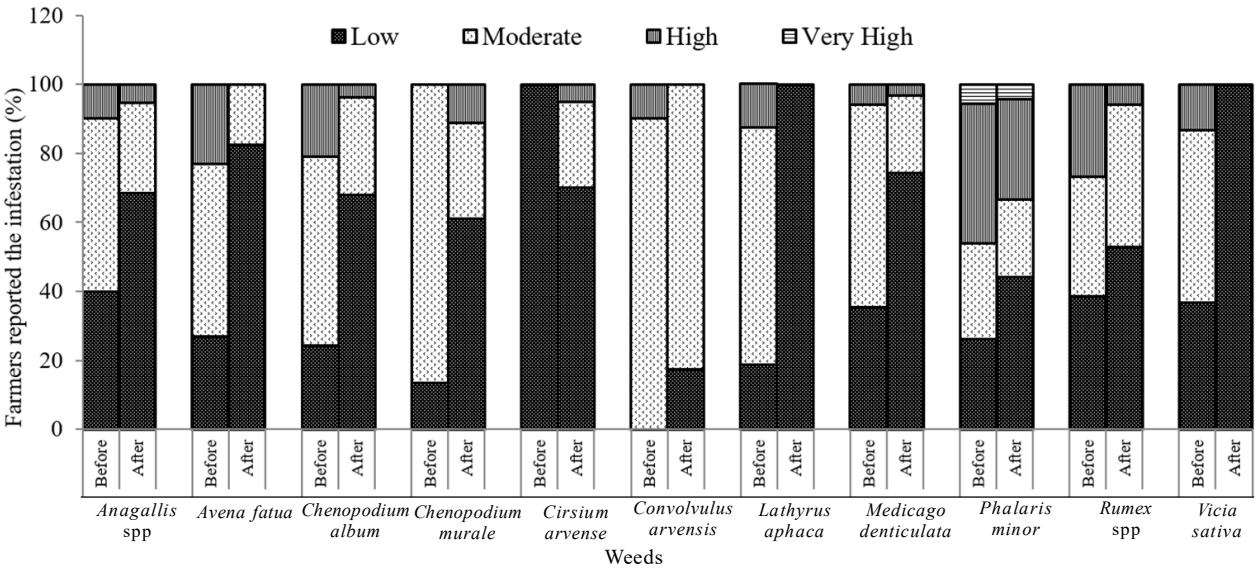

Figure 2. Response of farmers on weed severity (%) in wheat crop

Data on weed severity in rice before adoption revealed that *Setaria glauca* was reported by very few farmers with moderate level (25-50%) of infestation. However, this weed disappeared and new weeds such as *Aeschynomene* spp*, Phyllanthus niruri* and *Physalis minima* emerged with low severity level after the adoption of weed management technologies. Before adoption, some weeds like *Cyperus difformis, Fimbristylis miliacea, Ludwigia parviflora* were found in very high severity (>75%) level in rice crop, however, after adoption of weed management technologies they reached to low and moderate severity (<50%) in farmers' fields.

In case of wheat, few farmers reported *Melilotus indica* with low and moderate severity, however, it was not reported as problem weeds after adoption. On the other hand, *Polygonum* spp was reported with low and moderate severity after adoption. Some weeds like *Avena fatua, Chenopodium album, Phalaris minor* and *Rumex* spp were reported with high severity by >20% of the farmers before adoption. However, they were reported with low and moderate intensity after adoption. Few weeds like *Lathyrus aphaca* and *Vicia sativa* were reported with low level of severity after adoption of weed management technologies. Moreover, all weeds were reported with high level of severity (upto 75%) except *Phalaris minor*. According to 4.3% of the farmers, *Phalaris minor* is still present with very high level of severity (>75%) in most of their fields.

Awareness and adoption level of farmers on weed management

Information on awareness and adoption level of farmers regarding weed management technologies was collected with the help of interview schedule. These responses are presented though stacked bar diagram in **Figure 3 (a)** and **(b)**.

A1-Weeds are one of the major obstacles in crop production; A2-In traditional farming system, weed management was not given due importance; A3-Used demonstrated Improved Weed Management technologies later on; A4-Use of preventive methods of weed management.

B1-Use of precautionary measure such as mask, cloth, gloves during spraying; B2-Idea on spurious herbicides and their availability in the local market; B3-Use of separate nozzle like flat fan for spraying herbicides; B4-Destruction of herbicide container after use; B5-Mixing of herbicide with other pesticides.

Results revealed that farmers still not aware about the importance of weed management as they feel in case of other pests. However, 98% of the farmers use or have an idea of preventive methods to reduce the infestation of weeds in the crop. These preventive methods are (i) cleaning of seeds before sowing; (ii) cleaning of agricultural implements (iii) cleaning of irrigation channels and (iv) use of decomposed organic matter in the field. As far as chemical method is concerned, only around 50% farmers were well aware about the precautionary measures during spraying and spurious herbicides in the market. However, more than 80% farmers are mixing herbicides with other pesticides during spraying.

Major agencies involved in dissemination of weed management technologies

Analytic Hierarchy Process (AHP) was used to find out the major agencies which play important role in disseminating the weed management technologies. The AHP model used in this study is a qualitative technique which depend on the judgement and experience of decision makers to prioritize information for further better decisions. To arrive at the decision, different criteria and options (different

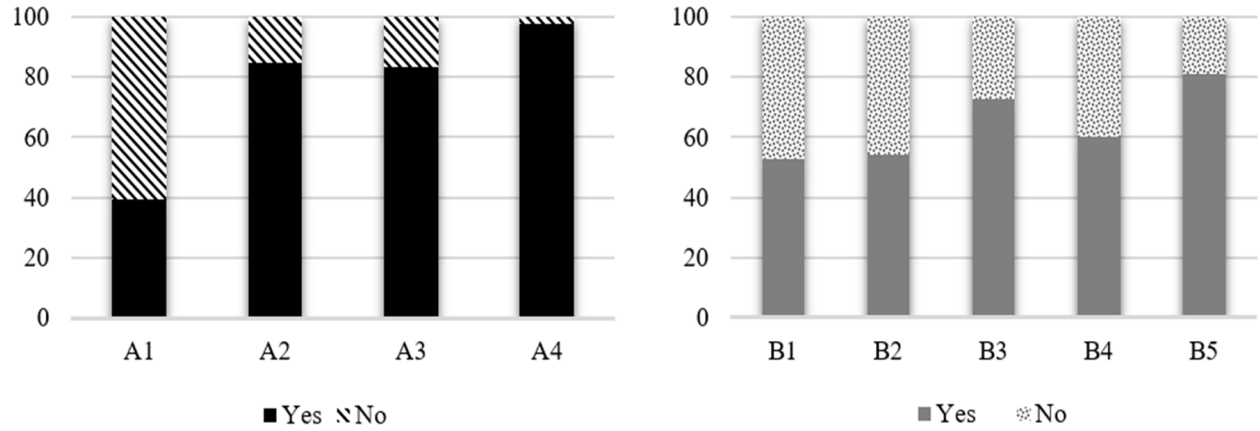

Figure 3(a). Farmers' perception on importance of weed management (b) Farmers' awareness level on chemical weed control

Table 2. Final priority of the agencies for disseminating the weed management technologies as a result of Analytic Hierarchy Process (AHP)

Agency	Final priority				
	Group I	Group II	Group III	Group IV	Group V
DWR/DWR centres / SAUs	0.34	0.28	0.37	0.56	0.35
Participation in OFR / demonstration conducted by DWR/DWR centres / SAUs	0.20	0.18	0.37	0.13	0.14
KrishiVigyan Kendra (KVK)	0.24	0.21	0.04	0.07	0.20
Kisan Mobile Seva	0.06	0.02	0.08	0.06	0.03
TV / Radio / News Paper / Literature	0.12	0.14	0.04	0.13	0.17
Private company / Local dealer / Others	0.03	0.17	0.09	0.04	0.10

agencies) were used and based on the feedback from farmers, AHP technique was used to arrive at the decision. Criteria used in AHP are (i) Contact with agency (ii) Frequency of contact to agency (iii) Information on weed management (iv) Receiving appropriate and useful information (v) Attempted received information (vi) Adopted recommended practice.

Table 2 revealed that ICAR-Directorate of Weed Research (DWR) and its centres located in different State Agricultural Universities played major role in disseminating weed management information to the farmers across all groups followed by farmers' participation in on-farm research /demonstrations conducted by these centres. In Group III, Krishi Vigyan Kendras were not found actively involved in spreading the information on weed control. As compared to Kisan Mobile Seva, TV/radio/ newspaper/literature and private company/local dealer/others also provided more information on weed management technologies to the farmers. There could be bias arising due to the inclusion of those farmers who were beneficiaries of DWR/DWR centres/SAUs for adopting those technologies. However, findings of this study may be used to know the other agencies which were not actively reaching to the farmers with weed management technologies. Therefore, there is need to sensitize those agencies and increase their role in providing weed management solutions to the farmers.

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