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A KNOWLEDGE TEST FOR CAULIFLOWER GROWERS ON AGROCHEMICALS AND PESTICIDE HANDLING PRACTICES

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ABSTRACT

Vegetables play an important role in ensuring food, nutritional and economic security and their production increasingly depends on the use of agrochemicals; however, improper use and handling of these inputs pose serious risks to human health and the environment. The present study was undertaken to develop and standardize a knowledge test to assess cauliflower growers' knowledge regarding agrochemical use and pesticide handling practices in the Jammu region. An initial set of 47 items was administered to 30 cauliflower growers selected from a non-sampled area. Item analysis was carried out by computing item difficulty and discrimination indices, and a dichotomous scoring procedure was followed by assigning one mark for each correct response and zero for each incorrect response. The reliability of the test was assessed using the split-half method and was found to be 0.74, while the reliability coefficient of the full test, estimated using the Spearman-Brown prophecy formula, was 0.85. In addition, Cronbach's alpha coefficient was found to be 0.81, indicating good internal consistency of the test items. Content validity was evaluated using the Content Validity Ratio (CVR) and Content Validity Index (CVI), with a scale content validity index (S-CVI) of 0.90. Accordingly, a total of 34 items were finally retained for the knowledge test. The developed knowledge test was found to be reliable and valid for assessing the knowledge of cauliflower growers regarding agrochemicals use and pesticide handling practices.

Keywords: *agrochemicals, pesticide handling practices, reliability, validity, item analysis*

INTRODUCTION

Agricultural practices have undergone significant transformation in recent decades, with modern farming systems increasingly relying on agrochemicals such as fertilizers and pesticides to sustain crop productivity under challenges including limited arable land, pest infestations and climate variability. While the use of agrochemicals has contributed to improved yields, their excessive and improper application poses serious risks to soil and water quality, biodiversity and human health (Kupa *et al*., 2024; Elumalai *et al*., 2025; Pal, 2023). Ensuring the safe and judicious use of agrochemicals therefore remains a critical concern in sustainable agriculture.

India, supported by diverse agro-climatic zones, ranks as the world's second-largest producer of vegetables after China (Kumari *et al*., 2025; Syed, 2022). Vegetables play a vital role in food, nutritional and economic security by providing essential vitamins, minerals, fiber and phytochemicals. Among vegetable crops, cauliflower (*Brassica oleracea* var. *botrytis*) is an important cole crop due to its high nutritional value and wide consumer acceptance. It is rich in vitamins A, B, C and K, essential minerals and bioactive compounds such as glucosinolates and sulforaphane, which are associated with protective effects against several chronic diseases (Sharma, 2021; Naik, 2024; Rakshita *et al*., 2021).

Despite cauliflower's pivotal role in regional food security and farmers' livelihoods, empirical studies on cauliflower growers' knowledge of agrochemicals and pesticide handling practices in the Jammu region remain scarce. Although many growers recognize the associated health and environmental risks, they often lack adequate training for the safe use of agrochemicals. Hence, the present study was undertaken with the specific objective to assess the knowledge of cauliflower growers about agrochemicals and pesticide handling practices using a standardized and validated knowledge test.

METHODOLOGY

According to Bloom *et al*. (1956), knowledge is defined as "those behaviors and test situations that emphasize the remembering, either by recognition or recall of ideas, material, or phenomena." It is regarded as a fundamental component of human behavior and plays a significant role in the adoption of agrochemicals and pesticide handling practices. For the purpose of developing and standardizing the knowledge test, it was administered to 30 cauliflower growers selected randomly from a non-sampled area. The study was conducted in the Jammu district of Jammu and Kashmir.

Collection of Knowledge items

To develop a reliable knowledge test, the items of the knowledge test assessing agrochemicals and pesticide handling practices among cauliflower growers were selected by systematically investigating related literature such as research papers, textbooks and through discussions with subject matter experts. The questions were revised and carefully formulated to ensure that each item was clear and free from ambiguity.

To develop a reliable instrument for assessing cauliflower growers' knowledge of agrochemicals and pesticide handling practices, the items were selected through a systematic review of relevant literature, including research articles and textbooks, and through consultations with subject matter experts. Each item was carefully revised and structured to ensure clarity and to eliminate ambiguity.

Editing and Correction of items

The initially developed items were further subjected to systematic evaluation and refinement. Through careful editing, modification, reorganization and by incorporating feedback from experts, the items were revised to enhance their accuracy, relevance and overall quality.

Item Analysis

Two important indices derived from item analysis are item difficulty and item discrimination (Guilford, 1954). The item difficulty index represents the degree to which an item is easy or difficult for the respondents, whereas the item discrimination index indicates the extent to which an item can distinguish between respondents with higher and lower levels of knowledge.

For this purpose, 47 items were initially developed focusing on agrochemicals and pesticide handling practices among cauliflower growers. These items were administered to 30 cauliflower growers selected randomly from a non-sampled area to minimize bias in the main study. A dichotomous scoring procedure was followed, wherein a score of one (1) was assigned for each correct response and zero (0) for each incorrect response.

The overall knowledge score for each respondent was obtained by adding the correct responses to all 47 items. Based on these scores, respondents were ranked in descending order and subsequently divided into six equal groups (G_1, G_2, G_3, G_4, G_5 and G_6.), each comprising five respondents as presented in Table 1.

Table 1. Respondent grouping based on knowledge scores

Group no.	G^1	G^2	G^3	G^4	G^5	G^6
Score range	32-30	29-25	24-23	22-21	20-16	15-7
No of respondents	5	5	5	5	5	5

The score ranges for each group were determined accordingly and subsequently used for the computation of item difficulty and item discrimination indices.

Difficulty index

The difficulty index indicates the level of complexity of an item or shows how challenging a question is for respondents. A question should neither be so easy that all respondents can answer it correctly, nor so difficult that almost no one can answer it (Abhishek, 2023; Khan *et al.,* 2024; Ansari *et al.,* 2024; Yadav *et al*., 2025; Manhas, 2022).

The difficulty index for each item was determined as the percentage of farmers who provided the correct response. It was calculated using the formula:

$P_i = (n_i / N_i) \times 100$

Where:

- P_i = Difficulty index (percentage) of the i^{th} item
- n_i = Number of respondents who answered the i^{th} item correctly
- N_i = Total number of respondents to whom the i^{th} item was given

Example of Difficulty index

Among the 30 respondents, only 13 responded correctly to the item. The item difficulty index was therefore determined as follows:

$P_i = (n_i / N_i) \times 100$

$P_i = (13 / 30) \times 100$

$P_i = 43.33$

Thus, the items with difficulty values between 20 and 80 were selected for inclusion in the final knowledge test.

Items discrimination index (E1/3)

The item discrimination index (E 1/3) indicates the degree to which an item can differentiate respondents with higher knowledge from those with lesser knowledge (Kumar *et al.*, 2015; Khan *et al.,* 2024; Ansari *et al.,* 2024). Item discrimination index was determined using the formula:

E 1/3

Where:

E 1/3 = Discrimination index of the item

N = Number of respondents to whom the items were given.

S_1 and S_2 indicate the counts of correct answers from the highest and higher scoring groups, respectively, whereas S_5 and S_6 show the number of correct responses from the lower and lowest scoring groups.

Items with a discrimination index value between 0.20 and 0.80 were selected for integration into the final knowledge test.

Example of Discrimination index of the first item

E 1/3 = ((4 + 2) – (1 + 1)) / (30/3)

E 1/3 = (6 – 2) / 10

E 1/3 = 0.4

Reliability of the test

According to Kerlinger (1967), "reliability is the accuracy or precision of a measuring instrument." A test is considered reliable when it produces consistent and stable results upon repeated administration to the same group of respondents. Although several methods exist to determine test reliability, the present study employed the split-half method and Cronbach's alpha to evaluate the reliability of the test items.

Split half method

In this technique, the test is split into two equal halves, with one half containing the odd-numbered items and the other half containing the even-numbered items (Ansari *et al.,* 2024; Khan *et al.,* 2024). After dividing the test, the correlation coefficient between the two halves was calculated using the designated formula:

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2]\,[N\sum Y^2 - (\sum Y)^2]}}$$

The correlation coefficient (r) between the two halves was found to be 0.74. Subsequently, the Spearman-Brown prophecy formula was applied to estimate the reliability of the full-length test and it was computed using the formula given below:

$$r_{\text{full}} = \frac{2r_{\text{half}}}{1 + r_{\text{half}}}$$

The reliability of the full-length test was found to be 0.85, indicating a high level of reliability.

$$\alpha = \frac{k}{k-1} \times (1 - \frac{\sum \sigma^2 y_i}{\sigma^2 x})$$

Cronbach's alpha was used as another method to evaluate the internal consistency of the test items. Introduced by Lee J. Cronbach in 1951, this measure assesses the extent to which a set of items are closely related and collectively measure the same underlying construct. In other words, it indicates the reliability of a test or scale, with higher values reflecting greater internal consistency. The value of Cronbach's alpha was calculated using the following formula:

α = Cronbach's alpha,

k = Number of items or questions included in the test.

σ_i^2 = Variance of scores for the i^{th} item

σ_T^2 = Variance of the overall test scores (i.e., sum of all items)

Σ = Sum over all item

The value of Cronbach's alpha was found to be 0.81. This value falls within the good range, indicating that the test is reliable.

Validity of the test

Validity is the degree of accuracy, how accurately a measuring device measures what it tends to measure (Khan *et al.*, 2025). Content validity was assessed in two steps. In the first step, the Content Validity Ratio (CVR) was calculated and in the second step, the Content Validity Index (CVI) was computed (Ansari and Khan 2023; Ansari and Manhas, 2025). The CVI was calculated for individual items (I-CVI) as well as for the overall scale (S-CVI).

CVR (Content Validity Ratio)

The Content Validity Ratio (CVR), developed by Lawshe, is used to determine whether an item is essential for measuring a specific construct within a set of items. In this method, a panel of experts evaluates each item by rating it as either "essential" or "not essential." Items rated as essential are assigned a score of 1, while those rated as not essential are scored 0 (Ansari and Khan, 2023; Khan *et al.,* 2024; Ansari *et al.,* 2024). The CVR is calculated using the following formula:

$$\text{CVR} = \frac{n_e - N/2}{N/2}$$

where = number of experts rating the item as «essential,»

= total number of experts.

Example of Content Validity Ratio (CVR): For a panel of 10 experts, if 9 rated an item as essential, the CVR is calculated as:

CVR= (N_e – N / 2) / (N / 2)

CVR= (9 – 10/ 2) / (10 / 2)

CVR= 0.80

Items with a CVR of 0.62 or higher, based on evaluations from the panel of ten experts, were retained for the final scale.

Content Validity index

The Content Validity Index (CVI) was employed to assess the overall relevance and representativeness of the items in the test. The CVI was calculated following the method proposed by Lynn (1986), using a 4-point relevance scale: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant. Based on this method, the item-level CVI (I-CVI) and scale-level CVI (S-CVI) were calculated using the following formulas:

I-CVI (Item-Content Validity Index)

Items with an I-CVI above 0.78 were considered valid, consistent with Lynn's guideline for sufficient content validity when the expert panel comprises six or more members.

The S-CVI was computed as:

S-CVI (Scale-Content Validity Index)

n = total number of items

Example: For the first item, if 8 out of 10 experts rated it as quite relevant or highly relevant (3 or 4), the I-CVI is:

I-CVI

I-CVI 0.80

S-CVI

S-CVI = 0.90

According to Lynn (1986), an S-CVI value above 0.80 is considered acceptable, while values exceeding 0.90 indicate excellent content validity. In the present study, the S-CVI of the test was 0.90, reflecting high content validity.

Table 2: Values of the final selected item in the knowledge test

Sr. No.	Item	Difficulty index	Discrimination index	Reliability	CVR	I-CVI	S-CVI
NURSERY MANAGEMENT							
1	Which chemical is used for seed treatment in cauliflower?	43.33	0.4		1.00	0.80	
2	Name at least one common disease found in cauliflower nursery	40	0.6		1.00	0.80	
3	Name of one fungicide which control the diseases in cauliflower	23.33	0.2		1.00	1.00	
4	What is the dosage of fungicide used for controlling diseases in cauliflower?	20	0.4		1.00	0.80	
5	Name most commonly found insect pests in cauliflower nursery	80	0.4		1.00	1.00	
6	Name of one insecticide which control the insect pest in cauliflower	46.66	0.3		1.00	1.00	
7	What is the dosage of insecticide used for controlling insect pests in cauliflower?	30	0.2		0.80	0.80	
8	Name commonly found weeds in cauliflower	73.33	0.3		1.00	0.80	

Sr. No.	Item	Difficulty index	Discrimination index	Reliability	CVR	I-CVI	S-CVI
9	Name of herbicide which control weeds in cauliflower	43.33	0.6		1.00	0.80	
10	What is the dosage of herbicides used for controlling weeds in cauliflower?	20	0.4		1.00	0.80	
FIELD MANAGEMENT							
11	What is the dosage of Urea in Cauliflower?	66.66	0.6		1.00	1.00	
12	What is the dosage of DAP in Cauliflower?	46.66	0.5		1.00	1.00	
13	What is the dosage of MoP in Cauliflower?	30	0.3		1.00	1.00	
14	Name at least one common disease found in cauliflower	46.66	0.8		1.00	0.90	
15	Name of one fungicide which control the diseases in cauliflower	30	0.4		1.00	1.00	
16	What is the dosage of fungicide used for controlling diseases in cauliflower?	23.33	0.4		1.00	0.90	
17	Name most commonly found insect pests in cauliflower	80	0.4		1.00	1.00	
18	Name one insecticide which control the insect pests in cauliflower	66.66	0.5		1.00	1.00	
19	What is the dosage of insecticide used for controlling insect pests in cauliflower?	60	0.3		0.80	0.90	
20	Name some weeds commonly found in cauliflower	73.33	0.3		0.80	0.80	
21	Name of herbicide which control weeds in cauliflower	43.33	0.6		0.80	0.80	
22	What is the dosage of herbicide used for controlling weeds in cauliflower?	20	0.4		0.80	0.80	
23	Which rodenticide is used for controlling rodents in cauliflower?	33.33	0.4		1.00	0.90	
24	What is the dosage of rodenticide used for controlling rodents in cauliflower?	23.33	0.2		1.00	0.90	
PESTICIDE HANDLING PRACTICES							
25	What is the ideal time of spraying pesticides?	43.33	0.3		1.00	1.00	
26	What is the ideal weather conditions during the application of pesticide?	60	0.2		0.80	0.90	
27	What personal protective equipments should be used at the time of spraying pesticides	53.33	0.2		0.80	0.80	
28	What level of toxicity 'Red' colour label indicates on an agrochemical container?	50	0.2		1.00	0.90	
29	What level of toxicity a 'Green' colour label indicates on agrochemical container?	36.66	0.2		1.00	0.90	
30	What are the different symptoms of insecticide poisoning?	66.66	0.2		1.00	0.80	
31	What precautions need to be taken during the purchase of pesticides	63.33	0.2		0.80	0.80	
32	Why is it essential to wash sprayers after application of pesticides?	30	0.2		1.00	0.80	
33	What are the hygienic methods for disposing off empty pesticide containers?	53.33	0.2		1.00	0.90	
34	What is the best practice for storing pesticides safely?	66.66	0.6		0.80	0.80	

RESULT AND DISCUSSION

The knowledge test developed in the present study was carefully analyzed through item analysis, along with reliability and validity analysis. The retained items showed acceptable ranges of difficulty index (20-80) and discrimination index (0.20-0.80), indicating that they can easily differentiate respondents according to their knowledge. Of the initial 47 items, 34 were retained after refinement.

The split-half coefficient was 0.74, and the Spearman-Brown corrected reliability was 0.85, while Cronbach's alpha (0.81) demonstrated good internal consistency among the items. These findings are consistent with recent studies by Ansari *et al*. (2024) and Khan *et al*. (2024), which reported similar reliability results.

The content validity of the instrument was high (S-CVI = 0.90), demonstrating strong agreement among experts on the relevance of the items, as reported by Ansari and Khan (2023) and Ansari and Manhas (2025). The final test comprised key domains, including nursery management, field management and pesticide handling practices, ensuring a comprehensive evaluation of farmers' knowledge.

Overall, the developed knowledge test is a reliable and valid instrument for assessing cauliflower growers' knowledge and can serve as a valuable tool for identifying knowledge gaps and informing targeted extension interventions.

The findings are in correlation with the studies of Rashmita et al. (2025); Chauhan et al. (2025); Purbia et al. (2025); Sindhura et al. (2025); Thakur et al. (2025); Vegad et al. (2021); Pratik and Vinaya (2022).

CONCLUSION

An effort was made to develop a standardized knowledge test to assess cauliflower growers' knowledge regarding agrochemicals use and pesticide handling practices. Item analysis, reliability and validity procedures confirmed that the selected items were appropriately difficult and effectively discriminated between cauliflower growers with different knowledge levels. The test was found to be reliable and valid for future use. Accordingly, the 34 items finally selected showed a good statistical fit for measuring cauliflower growers' knowledge of agrochemical use and pesticide handling practices.

RECOMMENDATION

The knowledge test can be effectively used by policymakers, researchers and extension personnel to better understand the knowledge of cauliflower growers regarding agrochemical use and pesticide handling practices. It can help identify existing knowledge gaps and guide the development of need-based training and extension programmes. Further, the test will support evidence-based decision-making for promoting safe, efficient and sustainable use of agrochemicals and pesticides in agriculture.

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CONFLICT OF INTEREST

There is no conflict of interest among the authors regarding this study

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