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Construction of a Knowledge Test on Papaya Ring Spot Virus Management Practices

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HIGHLIGHTS

- Developed and validated a 25-item knowledge test on PRSV management for papaya farmers in Bihar.
- Item analysis ensured high reliability (KR-20 = 0.92; Cronbach's α = 0.968) and strong content validity.
- It enables assessment of knowledge gaps and supports targeted training to improve PRSV management practices.

ARTICLE INFO

Keywords: Knowledge test, Papaya ring spot virus, PRSV management, Item analysis, Reliability, Content validity.

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ABSTRACT

The study was conducted during 2024–25 to develop and standardise a scientifically sound knowledge test for assessing papaya farmers' knowledge of Papaya Ring Spot Virus (PRSV) management practices in Bihar. An initial pool of 35 dichotomous items was prepared through an extensive literature review, expert consultation, and extension manuals. These items were pre-tested with 30 non-sample farmers, and item analysis was performed using the Difficulty Index, Discrimination Index, and Point-Biserial Correlation. Based on psychometric evaluation, 25 items representing preventive, cultural, chemical, and biological management practices were retained. The finalised test demonstrated high reliability, as indicated by KR-20 (0.92), split-half reliability (0.928), and Cronbach's alpha (0.968), while content validity was confirmed through expert judgment. The standardised tool provides an objective and reliable method to assess knowledge gaps, facilitate targeted training programmes, and evaluate extension interventions. It holds potential for broader application in papaya-growing regions to strengthen PRSV management and promote sustainable papaya cultivation.

INTRODUCTION

Accurate assessment of farmers' knowledge is a critical component of extension research, as knowledge provides the cognitive foundation for adoption of improved agricultural technologies and behavioral change. Psychometrically constructed knowledge tests are widely used to objectively measure farmers' understanding, as they ensure validity, reliability, and discriminatory power compared to unstructured surveys (Kesänen et al., 2014; Chandraker et al., 2021). Such tools are essential for identifying gaps, designing farmer-centric training programmes, and evaluating the effectiveness of extension and policy interventions. In the context of crop protection, where disease management practices often involve complex, multi-component strategies, reliable measurement of farmer knowledge becomes particularly important for ensuring technology dissemination and adoption.

Papaya (*Carica papaya* L.) is a highly significant horticultural crop in India due to its short gestation, high yield potential, and dual economic value as both a nutritional fruit and an industrial raw material. Though India remains the world's largest producer of papaya, with production of 5.24 million tones in 2023, yet disease pressures continue to limit its productivity (FAO, 2023; NHB, 2023). Among the biotic stresses, Papaya Ring Spot Virus (PRSV)

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is the most destructive, causing 50–80 per cent yield losses and threatening farmer livelihoods across major producing states, including Bihar (Chakraborty et al., 2019; Kumar et al., 2021). Transmitted in a non-persistent manner by several aphid species, PRSV spreads rapidly and is difficult to control with chemical measures alone, making integrated management strategies essential. Recommendations such as rouging of infected plants, use of border crops, raising seedlings under insect-proof nets, balanced nutrient application, and vector management using biological and chemical methods have been validated under research conditions (ICAR, 2021; Jacobsen et al., 2004).

Despite the availability of these integrated management practices, adoption among farmers remains inconsistent. Studies indicate that sub-optimal adoption is less a matter of technological availability and more the result of inadequate farmer knowledge, poor access to reliable advisory services, and dependence on pesticide dealers or informal networks for guidance (Myeni et al., 2019; Campenhout et al., 2020). While a few KAP (Knowledge, Attitude, and Practice) studies have attempted to assess farmer behavior in papaya cultivation, they often rely on non-standardized tools that lack precision and comparability. Without a validated and objective instrument, it is difficult to reliably measure actual knowledge levels, discriminate between low, medium, and high knowledge groups, or design targeted training programmes.

In this backdrop, the construction of a standardized knowledge test on PRSV management practices is essential. Although developed in Bihar, where PRSV incidence remains a major constraint to productivity, the tool has the potential for wider application in other papaya-growing regions of India facing similar challenges. By ensuring psychometric rigour in measuring knowledge, the study seeks to contribute both methodologically to extension research and practically to sustainable papaya production and farmer livelihood security.

METHODOLOGY

The study was conducted in Begusarai district of Bihar, with pre-testing carried out in Bachwara block, which was considered a non-sampling area to avoid bias in the main study. A preliminary pool of 35 knowledge items related to Papaya Ring Spot Virus (PRSV) management practices were initially developed through literature review, consultation with subject-matter specialists, and extension manuals. All items were framed as dichotomous questions, scored as "1" for a correct response and "0" for an incorrect response. The draft test was administered to 30 non-sample papaya farmers, and their responses were used for item analysis to refine the tool.

Item analysis was conducted using three statistical criteria: Difficulty Index, Discrimination Index, and Point-Biserial Correlation. The Difficulty Index (Garrett, 1996; Ray & Mondal, 2014; Vijayan et al., 2022; Vijayan et al., 2023) was defined as the percentage of respondents answering correctly, with an acceptable range of 30–80% for item retention. The Discrimination Index was computed using the E1/3 method (Mehta, 1958), which measures the ability of an item to differentiate between high- and low-scoring respondents, with acceptable values ranging between 0.30 and 0.75. Additionally, the Point-Biserial Correlation Coefficient (Garrett, 1996) was calculated to examine the relationship of each item with the total test score, ensuring that selected items had significant positive correlations at 5% and 1% levels of significance. Based on these criteria, 25 out of the 35 items were retained for the final test, representing preventive, cultural, chemical, and biological aspects of PRSV management.

The reliability of the knowledge test was assessed through internal consistency methods. The test was administered to 30 non-sample respondents, and all responses were found to be valid, ensuring 100% usable data for reliability analysis. The split-half method (odd–even division) was used, and the obtained correlation between the two halves was corrected using the Spearman–Brown prophecy formula. Additionally, the Guttman Split-Half Coefficient and Cronbach's Alpha were computed to determine internal consistency, following standard psychometric procedures adopted in earlier agricultural extension research (Lal et al., 2014; Lal et al., 2016; Kumar et al., 2016).

The validity of the knowledge test was established through content validation by a panel of experts comprising specialists in agricultural extension, plant pathology, and experienced farmers. The experts evaluated each item for clarity, relevance, and comprehensiveness, ensuring that the instrument adequately represented all dimensions of PRSV management and was both valid and reliable for measuring farmers' knowledge.

RESULTS

Psychometric item analysis

The item analysis revealed substantial variation in the performance of the preliminary 35 items. The difficulty index (P) of items ranged from 0.20 to 0.76. Items falling outside the acceptable range (i.e., <0.30 or >0.80) were excluded to ensure balanced representation of knowledge questions. Accordingly, 10 items were discarded as they were either too difficult (e.g. "Boerhaavia diffusa root extract effective for PRSV management" with DI = 0.13) or too easy (e.g., "Do oils like neem oil delay PRSV incidence?" with DI = 0.74). The remaining 25 items fell within the acceptable range (0.30–0.80) and were retained for the final scale.

The discrimination index (D) values of the items ranged between 0.10 and 0.55. Items with discrimination indices below 0.30 were eliminated, as they failed to effectively distinguish between high- and low-knowledge farmers. Out of 35 items, 25 items recorded D values between 0.30 and 0.55, and were therefore selected.

The point-biserial correlation (rpb) values ranged from 0.09 to 0.76. Items with rpb < 0.30 were considered weak and removed. Finally, 25 items with statistically significant correlations (at 5% and 1% levels) were retained, confirming that these items were consistent indicators of farmers' knowledge of PRSV management.

Validity of selected items

The validity of the items was established through point-biserial correlation analysis. Only those items with *rpb* > 0.30 were retained as valid. In addition, expert validation was undertaken by plant pathologists, extension scientists, and experienced papaya farmers to ensure that the selected 25 items comprehensively

Table 1. Item Analysis Outcomes: Difficulty, Discrimination, and Point-Biserial Metrics

S. No.	Items	Difficulty Index (%)	Discrimi-nation Index	Point-Biserial Correlation (rpbi)
1	Was the use of Nylon net (40–60 mesh) effective in reducing PRSV incidence?	60.00	0.55	0.573**
2	Does the use of yellow sticky traps help in reducing aphid population & subsequently PRSV incidence?	46.67	0.50	0.573**
3	Is the eradication of infected plants and host plants of aphids a method used to control PRSV?	53.33	0.30	0.431*
4	Did the use of row covers show any significant difference in PRSV incidence?	60.00	0.30	0.573**
5	Can removal (rouging) of infected plants reduce disease incidence in the field?	30.00	0.30	0.502**
6	Are there PRSV-resistant or tolerant papaya varieties available?	30.00	0.30	0.609**
7	Was the use of two rows of maize/sesbania as a border crop effective in reducing PRSV incidence?	63.33	0.50	0.538*
8	Can crop rotation help break the PRSV disease cycle?	70.00	0.50	0.690**
9	Can planting papaya in isolated areas help prevent PRSV disease?	66.67	0.10	0.681**
10	Should papaya be planted in the month of October after the rainy season to manage PRSV?	56.67	0.20	0.645**
11	Is a chlorine solution (70–100 ppm) recommended for sanitizing installations and equipment?	30.00	0.30	0.551**
12	Can planting rows in the same direction as wind increase disease spread?	56.67	0.30	0.551**
13	Does balanced fertilization help manage PRSV?	66.67	0.40	0.655**
14	Can training and pruning improve airflow and reduce disease risk?	43.33	0.40	0.538*
15	Is spacing between plants important for PRSV disease reduction?	66.67	0.30	0.645**
16	Is regular field monitoring and decision-making based on thresholds practiced?	70.00	0.40	0.690**
17	Can planting disease-free seedlings help prevent initial infection?	66.67	0.40	0.655**
18	Can removing PRSV-infected papaya plants as soon as symptoms appear reduce the chances of infection in healthy plants?	73.33	0.30	0.725**
19	Was Dimethoate (1.05%) effective in reducing PRSV incidence?	73.33	0.40	0.717**
20	Can Urea, Zinc Sulphate induce resistance against PRSV in papaya?	73.33	0.30	0.725**
21	Can Boron application prevent PRSV disease spread?	66.67	0.50	0.655**
22	Is Acephate effective in controlling aphid vectors of PRSV?	60.00	0.50	0.586**
23	Is Imidacloprid used to reduce aphid populations and PRSV spread?	70.00	0.50	0.690**
24	Do oils like Neem oil cake and Groundnut oil delay PRSV appearance?	73.67	0.50	0.760**
25	Can Neem Oil (7%) + sticker be used as foliar protection against PRSV?	73.33	0.50	0.725**

Legend: rpbi=Point-biserial correlation coefficient; ** "Correlation is significant at the 0.01 level (2 tailed)". "* Correlation is significant at the 0.05 level (2-tailed)"

represented the domain. Their critical review confirmed that the tool adequately covered the technical, cultural, and chemical management dimensions of PRSV, thereby establishing strong content validity.

Reliability of the knowledge tool

The internal consistency of the tool was assessed through multiple approaches, including KR-20 reliability coefficient, split-half method, and Cronbach's alpha. The KR-20 coefficient was found to be 0.92, indicating high internal consistency. The split-half method yielded a correlation of 0.869 between odd–even items, which, when adjusted using the Spearman-Brown prophecy formula, gave a reliability value of 0.928. Similarly, the Guttman Split-Half Coefficient was 0.927. Cronbach's Alpha of the final 25-item scale was 0.968, which demonstrates excellent reliability, far exceeding the minimum threshold of 0.70 recommended for social science research instruments (Lal et al., 2016).

Thus, the final PRSV knowledge test comprising 25 items was found to be both valid and reliable for assessing the knowledge of papaya farmers regarding Papaya Ring Spot Virus (PRSV) management practices.

DISCUSSION

The present study successfully developed and standardized a 25-item knowledge test to assess papaya farmers' knowledge of Papaya Ring Spot Virus (PRSV) management practices. The psychometric evaluation of the items revealed that the Difficulty Index values of the selected items were within the acceptable range of 30–80 percent, ensuring that the questions were neither overly easy nor too difficult. This balance is critical for achieving discrimination among respondents and aligns with the recommended standards for knowledge test construction in agricultural extension research (Ray & Mondal, 2014; Sinha et al., 2020). The Discrimination Index values (0.30–0.55) indicated that the retained items were effective in differentiating between farmers with high and low levels of knowledge, a finding consistent with earlier test development studies (Lal et al., 2015; Mehta, 1958).

The strong point-biserial correlation coefficients further established item validity, suggesting that each retained question contributed meaningfully to the overall measurement of PRSV knowledge. This finding is supported by previous works in psychometric tool construction, where point-biserial analysis has been emphasized as a robust method for identifying valid knowledge items (Garrett, 1996; Hopkins, 1998). Importantly, the incorporation of technical, cultural, and chemical control practices into the test ensured comprehensive coverage of PRSV management strategies, reflecting expert validation and contextual relevance.

The reliability analysis further strengthened the credibility of the tool. The KR-20 coefficient (0.92), split-half reliability (0.928), and Cronbach's Alpha (0.968) demonstrated excellent internal consistency, exceeding the generally accepted threshold of 0.70 for social science research instruments (Lal et al., 2016; Kline, 2000). These values also compare favorably with earlier studies on knowledge test construction in agriculture (e.g., Lal et al*.,* 2014; Sharma & Singh, 2023), underscoring the robustness of the PRSV-specific tool. The triangulation of multiple reliability measures further confirms that the instrument is stable and dependable for assessing farmers' knowledge.

The study makes a significant contribution to extension research by addressing a critical gap in plant disease management. While several knowledge tests have been developed for crop management practices, few have specifically targeted viral diseases in horticultural crops. By focusing on PRSV a major constraint in papaya cultivation the tool not only provides a standardized measure of farmer knowledge but also offers a practical basis for designing targeted capacity-building programs. Moreover, the inclusion of practices such as roguing, resistant varieties, border cropping, reflective mulching, and safe pesticide use ensures that the tool is aligned with integrated pest and disease management approaches, thus promoting sustainable solutions.

In summary, the developed knowledge test is a scientifically validated, reliable, and context-specific instrument for assessing farmers' knowledge of PRSV management.

CONCLUSION

This study developed and standardized a 25-item knowledge test specifically designed to assess papaya farmers' understanding of Papaya Ring Spot Virus (PRSV) management practices. The tool, validated through expert judgment and psychometric analysis, demonstrated excellent reliability and internal consistency, ensuring its scientific soundness. By encompassing cultural, preventive, biological, and chemical control measures, it provides a comprehensive means of evaluating farmer knowledge. Beyond research utility, the test can serve as a practical tool for extension professionals to identify knowledge gaps, design targeted training programmes, and monitor the effectiveness of interventions. Thus, the standardized knowledge test represents a valuable contribution to extension research and practice, with the potential to strengthen PRSV management, enhance technology adoption, and support sustainable papaya cultivation and farmer livelihoods.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the 30 non-sampled farmer judges of the statements/ items regarding the study during the course of the data collection.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, they thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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